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ECONOMIC STATUS OF MEN AND WOMEN IN THE PROFESSIONS

SCIENTIFIC workers who are bold enough to glance through the two hundred pages of the report of the Asquith Commission on Equal Pay will not find it easy at first to discern its exact bearings on their own activities. A brief chapter on the professions, and the sections on the non-industrial Civil Service and the Post Office in that on the Central Government Service, the chapters on the teaching service and on the local government services other than teaching, are the portions of the factual survey forming Part 1 of the report which obviously closely concern particular categories of men of science. Another chapter in the same part reviews equal pay in the United States of America, in Australia, in France and the Union of Socialist Soviet Republics. In Part 2, where the implications of the claim of equal pay for equal work are considered at length, the physiologist and psychologist may find something of interest in the discussion of the natural factors responsible for the prevailing differences in the remuneration of the labour of men and women and of the psychological effects of equal pay, as well as of the effects on the health and efficiency of women as workers. It is, however, on these explanations of the prevailing differences that there is a memorandum of dissent by Dame Anne Loughlin, Dr. Janet Vaughan and Miss L. F. Nettlefold, and there is a further reservation by Lord Justice Asquith, Sir Jasper Ridley and Prof. D. H. Robertson on the question of over-strain.

It is accordingly no surprise to find that the only approach to a summary is a paragraph directing attention to passages in which the conclusions of the Commission are briefly crystallized, and that these conclusions are limited to the social and economic effects of applying equal pay to the Civil Service, to teachers and to local government officers other than teachers. The general implications for industry are left open to debate, and although the consequences of its application, which in the Commission's view are common to all spheres, are considered at large in a further chapter, on one point raised the Commission was not unanimous. The purely financial consequences of equal pay are discussed in a final chapter, in which it is estimated that introduction of equal pay in the non-industrial Civil Service on the basis of 1939 figures would involve a gross annual cost of £4 millions, or £13 millions on the basis of the October 1944 numbers and sex-distribution. The probable increase when the Civil Service has settled down to its peace-time strength and sex-composition might lie between £5 millions and £10 millions. For England and Wales, the Ministry of Education estimates that the annual cost of raising the salaries of women teachers to the men's level would be about £14·5 millions, while for other employees of local authorities the Commission estimates the annual cost at about £750,000.

Turning now to the factual part of the report, which since the report is rather the opening chapter

of a new volume of discussion than the basis for action—in any event until ample time has been allowed for digestion—is probably the more important, no evidence was submitted of women with professional status charging lower minimum fees than men with the same status. Evidence from some professional bodies showed that their recognized scales provide for the charging of identical fees by men and women. As regards salaried posts, a broad distinction is drawn between employment in the public service and employment outside. In the Civil Service, women medical and dental practitioners receive the same salaries as men; but the principle of equal pay has not been accepted as yet for other professions, although the Royal Institute of British Architects is pressing the case for equal pay for men and women architects in the Government service.

Some witnesses suggested that outside the public services there was no differentiation between men and women as regards remuneration, and evidence submitted to the Commission indicates that professional men and women actually receive equal salaries for the same work, outside employment in central and local government, when practising as medical practitioners, dentists, physiotherapists, radiographers, university teachers and journalists and librarians in technical or specialized libraries in industry. Women pharmacists working for hospitals or for wholesale and manufacturing chemists are also stated to receive, in general, the same rates as men. A small section of the evidence submitted, however, indicated discrimination in salaries between men and women; for example, in retail pharmacy, welfare work and personnel and labour management. A table giving the numbers of men and women in certain professions shows the extreme variations of the sex distribution, from about 3,000 women out of 6,000 librarians, according to an estimate made by the Library Association, 7,198 women out of 44,341 medical practitioners, 2,667 women out of 25,224 pharmacists, 549 out of 15,404 dentists, 325 out of 9,700 architects and 261 women out of more than 9,000 chemists.

Passing now to the few conclusions drawn in the report, the Commission states that there is no reason to suppose that the grant of equal pay in the Civil Service would have as corollary a change in the policy of recruitment designed to restrict the employment of women, and while the present system of recruitment remains in force it is unlikely that equal pay would have the effect of increasing to any important degree the proportion of women in the Civil Service, although some increase may naturally be expected. Such increase is likely to be most marked at the administrative level, and is likely to be accompanied by an improvement in the quality of the persons recruited. The consequences are only likely to be important—and adverse—if the common rate is not held at a level at which it competes effectively with the rates payable outside the Service to men of the type and quality which are required. The effects in the local government service, other than teaching, are considered as likely to be broadly similar but slightly less impressive.

As regards teaching, the Commission considers that any risk that the quantity or quality of male recruits would be adversely affected by a system of equal pay would be more than offset by the natural effect of such a system in attracting more or better women to enter the teaching profession. It also emphasizes that the grant of equal pay would redress a sense of injustice which the majority of teachers, men as well as women, rightly or wrongly entertain.

It is not easy in reading this report 'to see the wood for the trees', and there are many points which cannot well be viewed in their proper perspective against the scanty conclusions already noted. Discussing, for example, the marriage bar in relation to equal pay, the Commission observes that in the professional, administrative and technical classes of the Civil Service, the bar is harmful so far as it increases the natural wastage, and results in a further shrinkage of the pool from which women in whom much training and experience has been sunk can be made available for filling the highest posts. Against this, of course, has to be set the risks of inconvenience and embarrassment to the public service from endeavouring to retain in employment women who may require considerable spells of maternity leave, and whose domestic duties may restrict their mobility and their availability for the long hours of work which may be required at times of crisis and pressure.

The report makes it abundantly clear that, for most professional and administrative workers, the change-over to a regime of equal pay for the two sexes involves a serious clash of equities and social purposes. Some of those may be resolved by Government social policy as regards children allowances, income taxation and the like outside the terms of reference of the Royal Commission; but their existence tends to reinforce the argument which the Commission displays for Government initiative. It is argued with force that, if equal pay is to be introduced immediately and as an act of deliberate policy in any sphere, the 'area' of its introduction should be confined to those same spheres of non-industrial Government employment to which the Commission's own conclusions have been restricted. That step might well be justified at the moment as helping to meet the need for trained man-power and woman-power at the administrative level; and although as indicated in the report there are considerable difficulties in the way of adoption of an equal pay policy in private industry and commerce, it is almost certain that Government initiative in the spheres indicated would be followed at least tentatively by many sections of industry in corresponding fields.

Whatever is done in any part of this field may be expected to have strong reactions elsewhere, and in directing attention to the probability that private industry would probably follow a Government lead, the Commission comments mildly on the argument put forward by the Treasury against the Government taking action independently of employers in Britain generally. The Treasury, it seems, fears that changes in the large field of employment which it controls in the non-industrial field would have too large an effect on outside practice. At the same time, however,

the Treasury resisted the introduction of equality in the Government's industrial establishments because, before the War, they covered such an extremely small part of the industrial field that the Government could not attempt to exercise a dominant influence in the sphere of industrial wages. This unconvincing attempt to make the best of both worlds and do nothing might well have received more pointed rebuke. It may be wrong, for reasons given in the report, to argue from the consequences of establishing equal pay in the public service to the consequences of establishing it in private industry; but there is a strong case for throwing the example and influence of the Government on the side of reducing the gap between the pay of men and women at the present time. If the adjustment is to be faced, it is well for it to be done while the relationships of costs, selling prices and the value of money are still in flux; and as a recognized instalment of social justice and an increment to the labour force, there are immediate benefits to be set against the cost.

There are, therefore, chapters of this report which scientific and other professional workers will do well to ponder, and the absence of definite conclusions should not prevent them from forming their own as to the effect and implications of the adoption of equal pay in the Civil Service, and probably also in commerce, following a Government lead. The factors to be weighed are duly set forth, and the minority report, which seeks to distinguish more clearly between opinions and evidence, reflects a more advanced and buoyant attitude than that of the majority, although it might have been more fully and cogently displayed. Both majority and minority reports, however, are a distinct contribution to clearer thinking on the many issues involved, and they deserve in particular careful study by all professional associations concerned with the economic status of their members. On what is said as to career value and the relative turnover of women as compare withd men staff; the trend towards the substitution of mechanical for muscular power; and the truism that no material object or human quality derives value merely from the fact that it is uncommon, but only from the fact that it is scarce relative to the demand for the services which it is capable of rendering, there is room for further objective thinking by such bodies, as well as by individuals, before action is taken even on the limited findings of the Commission.

THE FUNCTIONAL *A PRIORI*

The *a Priori* in Physical Theory

By Arthur Pap. Pp. xi+102. (New York: King's Crown Press; London: Oxford University Press, 1946.) 13*s*. 6*d*. net.

THE King's Crown Press is undertaking the admirable task of making the contributions of scholars more readily available than they might otherwise be if they always had to carry the full 'editorial attention' of Columbia University. There is no diminution in quality; rather it is a case of 'high thinking and low living', but with a somewhat tempered austerity, altogether appropriate to a monograph on a philosophical theme.

Dr. Pap will be known in Great Britain by his lucid paper on "Indubitable Existential Statements" (*Mind*, p. 234, July 1946); in the present context he appears as the expositor of a certain doctrine, namely, the functional, of the *a priori*, both in its historical aspect and in its application to classical physics. In both these domains he is strongly under the influence of C. I. Lewis and of Poincaré, though he does not hesitate to launch out on his own into deep water as opportunity offers.

Before making any detailed comments, it may be permitted to invite those seriously interested to have a copy of Prof. E. A. Milne's "Fundamental Conceptions of Natural Philosophy" (Scott Lecture, Royal Society of Edinburgh, 1943) before them when they tackle the thesis now under review. The point is this. Milne devotes considerable attention to classical physics, comparing them closely with his new theoretical edifice in process of construction. The core of the whole adventure, however—for it is nothing less—is an insistence upon the supreme significance of epistemology, and upon the need to use it properly. Now this is just what Dr. Pap has done, and done very well. In fact, whether he had this in mind or not when writing his manual (for he is silent on the question), the conjunction could scarcely be better. In parallel or in series, these contributions form a natural pair, which is not because they are alike; it is because for both it is the epistemology that matters.

From here, as from a springboard, we may well take off to follow up this new work. In Part 1, as already indicated, the treatment is largely historical, and in Part 2, in application to Newtonian mechanics. The discussion seems to be airborne from the start: the groundwork is good, but the reader is soon given wings. This applies both to the text itself and to the footnotes. The latter contain much valuable material, not clogging the machinery, but acting, as it were, as a lubricant.

Some early paragraphs show Lewis as a pragmatist, so far as the *a priori* is concerned. It is difficult to see what difference there is between his view and the essentially 'John Blunt' statement that *a priori* means 'true, no matter what'. This may well be, but he rejects, as Kant did, the *tabula rasa*; the mind does not start for Lewis with a clean sheet; but he will have none of the "*a priori* forms of induction", nor of the "synthetic *a priori*" either. Altogether, this seems a trifle 'queer'—to use an adjective which the Harvard philosopher employed in another connexion. Dr. Pap's *a priori* is rather gentler and, as he says, "may well be viewed as susceptible of *degrees*". The impact of Poincaré's "La Science et l'Hypothèse" on the writer is more profound, and brings about a certain axiological orientation almost amounting to a species of requiredness. At the same time, there is a strong leaning towards physics, as indeed there must be if Poincaré's thought is to bear fruit.

Alongside, another notion is ably handled, namely, that of 'real definition'. A quotation from John Stuart Mill follows, which, if taken in its original context, makes the position most intriguing. Mill had, in fact ("System of Logic", 1, Chapter 8, Section 5), just been discussing Archbishop Whately's "Logic", in which real definition is taken to contain more than is implied in nominal definition, whereas De Morgan held just the reverse (always assuming, of course,

that the content is enough for distinction), his real definition having a smaller content than the nominal. Real definition seems fundamentally afflicted with a certain fuzziness: it is interesting to compare the two for the case of formal implication, remembering that 'nominal' refers to notation. Thus, in the usual symbols:

$$(F)(G)[[F(x) \supset_x G(x)] \equiv (x)[\sim F(x) \vee G(x)]] \ldots \text{(real)},$$

and

$$F(X) \supset_X G(X) \ldots \text{(nominal)}.$$

One might almost see in this a perpetual distinction between the methodologies of the mathematical and classificatory sciences, the former, as Dr. Pap points out, favouring definition by postulate (unknown to Mill), and the latter explicit definition, that is, the traditional *definiendum* → *definiens*. As a long footnote explains, unambiguous discriminants between the two can be obtained. More generally, Whately's charming Aristotelianism may again find favour in our day, though doubtless in a rather different dress.

Meanwhile, a few pages ahead, a somewhat crucial state of affairs is reached for *definiendum* and *definiens*, in virtue of the synthetic-analytic shift of meaning and the consequential generalization by selective abstraction. Naturally enough, the old anthropomorphism of force appears here, and a reference is given to the Kasimir Ajdukiewicz concept known as the *Begriffsapparatur*. This is a kind of language pattern, tightly connected and bounded with respect to meaning. But for once, what Dr. Pap has in mind about this is not entirely clear. Now Ajdukiewicz has three kinds of rules—axiomatic, deductive and empirical; what exactly they, and they alone, have to do with the difference between force (synthetic) and force (analytic) is hard to see. It may be that the text suffers from excessive condensation; but the truth behind this distinction is of the greatest significance in view of the close correspondence between Poincaré's 'principles' and 'conventions' with the first and third rules of the *Begriffsapparatur*. In point of fact, Ajdukiewicz considers that our whole outlook is a function of language as well as of experience.

Thus far for the functional *a priori* itself: we now approach its application to Newtonian mechanics. Dr. Pap begins by reminding us of the relations and *Grundsätze* of Kant, and their assumed position with regard to Newton's laws of motion; namely, the principle of the permanence of substance, the principle of causality, and the principle of reciprocity on one hand, and the law of inertia, the law of the proportionality of force to acceleration, and the law of action and reaction on the other. One illustration, from the law of inertia, must suffice to illustrate the structure of the author's thought. Here it is argued that, in general, the fundamental laws of Nature contain an experimental element and a conventional element; or, otherwise expressed, there is a dichotomy into an *a priori* component and an *a postiori* component. As an example of this dual character, the first law of thermodynamics, $dU = dQ - dW$ is mentioned. Mathematically, this merely amounts to defining internal energy in terms of measurable quantities; the physical significance appears when dU is established as a perfect differential, for this means the usual conditions and result for, say, a Carnot cycle. It looks as if much of the difficulty commonly encountered in mastering classical thermodynamics is traceable to the undue haste with which the subject is usually presented, lacking a clear epistemological basis, while the perfect differential emerges as a species of *deus ex machina*.

Whether or not it would be strictly germane to the author's purpose, the impression remains that this section would have been enriched by a discussion of Carathéodory's axiomatic thermodynamics, either in the original form or in the more readily grasped version given later by Prof. Max Born. The objection, supposedly, would be that an analytic, quasi-geometrical conception is not in the spirit of Newtonian physics, at least in the traditional setting. But perhaps nothing would mirror with less distortion the main tenets of Dr. Pap's philosophy. This is not a criticism, only a plea.

While on these subjects, a word or two upon what the writer calls "the graphical idealization of distributions of experimental values", or the principle of uniformity. This, of course, is a well-known assumption revived, namely, that a functional relation connecting verified data will hold for values not actually measured, and which, moreover, may never in fact be measured. In practice, it has not infrequently been necessary to rescue the principle of uniformity from disruption, and one way is to increase the number of parameters of a simple analytic function, say, the general gas law, $pV = RT$. In brief, we start with $f(p,V)$, then suspecting that temperature is the culprit, we write $f(p,V,T)$; lastly, we save the situation by increasing the dimensionality, thus putting $(p+a/V^2)(V-b) = RT$, so retaining our continuous function.

Some such process is involved when efforts are made—as they occasionally are—to set up a natural philosophy of 'real' substances in contradistinction to the simplified bodies necessarily envisaged in academic science. Alternatively, it may be desirable to approximate to a widespread imperfection (or defect), such as that manifested by 'real' crystals. But the fundamental importance of a grasp of the principle of uniformity remains; otherwise there is a grave risk of becoming profligate, and inviting due retribution from Occam's razor.

These topics, and many more, form the raw material out of which Dr. Pap has fashioned his last chapter, that on idealization in physics. They all tell the same story—the need for a sound epistemology and for the will to use it.

An adequate set of notes and a bibliography provide a final reminder of the wide field covered by this monograph, and of how much yet remains to be brought under the plough. F. Ian G. Rawlins

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SCIENTIFIC BASIS FOR SYLVICULTURE

Forest Soils and Forest Growth

(Plant Science Books, Vol. 18.) By Assoc. Prof. S. A. Wilde. Pp. xxii+242+7 plates. (Waltham, Mass: The Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1946.) 5 dollars.

DR. WILDE'S book is written for practical foresters and forestry students, whose success or failure in their work will be judged by volume and quality of crop production combined with maintained soil fertility. His main theme is summed up in his preface: "an understanding of the forest lies just as much below as above the ground"; but in the text more space is given to a consideration of soils than

vegetation. From the point of departure he passes, after an introductory chapter, to a discussion of the genesis and classification of forest soils, followed by a series of short chapters on forest cover, soil properties, soil survey, sylviculture and forest nurseries. The great virtue in the author's treatment of these subjects lies in his conception of soils as dynamic systems. Each type has its own morphological structure and pedological activity which is integrated completely with the structure and activity of the living community dependent upon it. He does not use Prof. Tansley's term 'ecosystem'; but the concept is clear. The virgin forest, the exploited forest, the plantation and even the forest nursery are viewed as possible systems of this kind maintained either by natural or anthropogenic forces. The aim of the forester is to extract from such systems the maximum volume and quality of his product while maintaining by suitable treatment stability or rhythmic change within it. By a combined study of pedology, ecology and physiology, Dr. Wilde has attempted to find a scientific rationale for sylvicultural and nursery operations.

Such is the impression given by a complete reading of the book as a whole; but equal justice is not done to all parts of the subject, and one is left with a profound feeling of disappointment. The material presented was based originally upon a series of lectures given to a heterogeneous group of students, and this origin seems to have determined the mode of presentation. It is doubtless also responsible for the inclusion of most of the less-important material. The size of the subject, as defined in the title of the book, is huge; and alone would have been sufficient to fill the two hundred pages available. Nevertheless, chapters or sections are included on the purely technical or elementary aspects of soil survey, tree-felling, mensuration, extraction and parasite control which are sufficient only to whet the appetite of the reader or to distract his attention. The omission of some of this material would greatly have improved the balance and order of the all-important remainder. The most regrettable feature is the restriction of the discussion on the biological structure of forest cover to one short, inadequate chapter of eight pages in which the interdependence of sylviculture, ecology and soil science is included. This defect is partly rectified by a valuable later chapter on soil-forest types in which a comparison is made between communities of the United States and those of other parts of the world. Surely these two chapters might have been more closely related to one another and to that upon soil organisms, which again is somewhat simplified and placed among chapters on soil properties. In short, the book is so composed and constituted as to make it very difficult for the reader to obtain a clear panorama of the whole subject.

The treatment of soil genesis and classification contrasts sharply with the remainder, both in its detail and in its arrangement. It will be to this part of the book that one will return for reference. The classification of forest soil types is summarized by a table in which each 'macro-climatic-soil-forest zone' is subdivided into its principal genetic types on the basis of degree of leaching. In the following text each type is described with examples of structure, analysis and associated tree species in most cases. The author stresses that there is a dearth of accounts correlating pedological and ecological observations upon soils of the lateritic group. He has, however, produced an outline of the forest soils of tropical regions which is worthy of further consideration.

As has been suggested, much of the detail of the last eighty pages might better have been omitted so that the sylvicultural and nursery principles and practice could have been more closely related to the fundamentals laid down in the first part of the book. Each of the short chapters in these pages is in itself a clear account of some practical operation, even though it is not closely related to the general text.

The book is printed and bound to conform with the sister volumes of a new series of *Chronica Botanica* publications, and it is illustrated with clear black-and-white figures in the text. The plates, which are interleaved with the index, are often too small and too crowded, but the tail-pieces to the chapters are delightful. To sum up, it must be realized that Dr. Wilde has undoubtedly approached his subject from a new angle, and that the book is a step towards the consolidation of the many branches of academic study which unite in the practical subject of scientific forestry.

J. L. HARLEY

X-RAY AND ELECTRON DIFFRACTION IN FLUIDS

The Diffraction of X-Rays and Electrons by Free Molecules

By Dr. M. H. Pirenne. (Cambridge Series of Physical Chemistry.) Pp. xii+160. (Cambridge: At the University Press, 1946.) 12*s*. 6*d*. net.

THE present monograph is intended to give an account of the phenomenon of diffraction of X-rays and electrons by gases and the methods for determining the structure of atoms and molecules based on the observation of this phenomenon. But it also deals to some extent with the scattering of X-rays by crystals and by liquids in so far as these phenomena can be used for the same purpose.

The first part of the book deals with the classical and quantum theory of the coherent and incoherent scattering of X-rays and the mechanism of the fluorescent radiation of atoms, the experimental measurement of the scattering by monatomic gases and crystals, and the comparison of the results of these measurements with theory. The scattering of fast electrons is then treated in a similar way. Next the diffraction of X-rays by free rigid molecules is considered theoretically and the theory verified by experiments on gases consisting of simple molecules. This is followed by considerations on the effect of the mutual interference of molecules in dense gases and especially in liquids, owing to the existence of a radial distribution function. The next part of the book deals with the refinement of the theory by taking into account the internal thermal movement of the atoms within the molecule and the distortion of the electronic clouds of the atoms connected with the chemical bonds. This is followed by a discussion on the use of X-ray and electron diffraction measurements on free molecules for the determination of their geometrical structure and, in particular, the use of Fourier analysis of diffraction patterns for this purpose. Finally the experimental methods for the measurement of X-ray scattering functions of gases are described in detail, especially the methods developed by the author himself. A list of molecules studied by these methods, a table of atomic scattering functions and a bibliography are added.

The book is in the first place written for scientific workers who wish to engage in research on the structure of molecules. There is therefore no attempt to derive the theoretical formulæ from first principles, and at every step the theory is put to the test by comparison with experiment. The virtues of the different methods, the errors to be avoided and the corrections to be applied are very thoroughly discussed; but perhaps a little too much space is taken up by the detailed description of the author's own work as compared with the work of others. Those readers who wish to use the book as a source of general information on the subject would have preferred to find a short systematic theoretical treatment of the scattering of X-rays and electrons on the basis of quantum mechanics, which would greatly help towards a better understanding of the connexions between the different forms of the scattering phenomenon.

There are a few minor errors; for example, the statement on p. 21 that the frequencies in the spectrum of the incoherently scattered radiation are all smaller than the primary, or the statement on p. 26 that in coherent scattering the primary photon is first captured by the atom and then re-emitted again in its entirety. The discussions on pp. 12 and 28 on the quantum mechanical wave function are incorrect as they omit to take into account that these functions are complex and not real. The explanation of the resonance effect produced by the K-frequencies on the dispersion of the atomic scattering factor on p. 38 is also misleading.

Apart from these minor defects the book is very lucidly written and accompanied by a great number of clear diagrams and illustrations. It can be warmly recommended. R. FÜRTH

CHEMISTRY AND LIGHT

The Chemical Aspects of Light

By E. J. Bowen. Second edition revised. Pp. iv+300. (Oxford: Clarendon Press; London: Oxford University Press, 1946.) 15*s.* net.

MR. BOWEN writes in his preface that "the second edition of this book has the same aim as the first: to present modern ideas of matter and light as far as possible in non-mathematical form. . . . Wave mechanics is a difficult subject which cannot by its intrinsic nature be conveyed in a pictorial form, yet such a theoretically unsound task is what is attempted here". There can be no doubt that Mr. Bowen has succeeded in his task; moreover, the task itself has increased in magnitude since the first edition was published; and, in general, wave mechanical topics have been treated more deeply in the second edition.

The arrangement of the book remains approximately the same; but the text has been largely rewritten and extended. The early chapters on light and waves, and light and light sources remain sensibly unchanged. Chapter 3 on the absorption and emission of light has been considerably enlarged. The main addition is a discussion of molecular orbitals, and their construction from and relation to the corresponding atomic orbitals. In the course of this, carbon–carbon single and multiple bonds, and conjugated systems, including benzene, are dealt with. There follows a very interesting account of 'colour', in which the position, shape and intensity of absorption bands are related to molecular structure, molecular orbital and resonance methods being used. Chapter 4, on the transformation of absorbed radiation, now includes a discussion of the kinetics of the quenching of fluorescence in solution, and the information which may be obtained by a study of quenching about reactions in solution with high velocity constants.

Typical additions in the remaining chapters are the discussion of a number of photochlorinations, and geometrical isomerizations (Chapter 6) and the recent Russian work on photosynthesis (Chapter 7). There are also two additional appendixes: one on filter solutions, and a comprehensive list of "Experiments with Light of Chemical Interest".

For readers who are not familiar with the first edition, it may be stated that the book is written in an extremely lucid and attractive style, and will be useful not only to students as an introduction to several aspects of chemical physics, but also to practical photochemists. The author is to be congratulated on adding substantially to the value of an already excellent book. It is a pity that references to original papers have been omitted from the second edition.

The price is very reasonable.

C. H. BAMFORD

LEGENDRE POLYNOMIALS

British Association for the Advancement of Science

Mathematical Tables. Part-Volume A: Legendre Polynomials. Prepared by the Committee for the Calculation of Mathematical Tables. Pp. A42. (Cambridge: At the University Press, 1946.) 8*s.* 6*d.* net.

THIS is the first of a post-war series of mathematical tables published for the British Association, in response to the ever-growing demand arising from research work in mathematics and physics.

It is designated Part-Volume A, and appears in conjunction with a companion volume on the Airy integral. Unlike the other recent publications dealing with the tabulation of Legendre functions, this book makes no reference to the associated functions and is concerned only with the polynomial solution of Legendre's differential equation:

$$(1-x^2)\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + n(n+1)y = 0,$$

for integers n ranging from 2 to 12 inclusive.

In the first section, tables of $P_n(x)$ for $n = 2$ to 6 are provided for the range $x = 0$ to 6 at intervals of 0·01. The entries are, in general, accurate to seven significant figures, and second differences are supplied.

The second section deals with the next three functions with similar accuracy, fourth differences being included where necessary. The remaining three functions are tabulated in the final section.

The whole production has been supervised by Dr. L. J. Comrie and is prefaced by his introduction, which describes the material on which the tables are based, together with the methods used in their construction. With his characteristic thoroughness, Dr. Comrie has provided means for ensuring the complete accuracy and legibility of every figure, and one can look forward with confidence and pleasure to future publications of a similar nature. J. H. PEARCE

INTERNATIONAL CONTROL OF ATOMIC ENERGY*

STATEMENT FROM THE COUNCIL OF THE ATOMIC SCIENTISTS' ASSOCIATION

THE United Nations Atomic Energy Commission has before it the two alternative proposals by the American delegate (Baruch plan) and by the Russian delegate (Gromyko plan). Mr. Philip Noel-Baker stated in the House of Commons on August 2 that there is no fundamental clash of principle between these two plans, and that they need to be fused; we share his belief that efforts must be continued to find a workable scheme acceptable to all countries.

We have come to the conclusion that the points on which the nature of the disagreements has been brought out most clearly are concerned with the stages by which an ultimate solution is to be approached.

A. Immediate Action

The most important objection to the Baruch plan from the point of view of other nations is probably that it envisages in its first stages measures which may be construed as maintaining the dominance of the United States in the field of atomic energy, whereas the concessions which are to be made by that country appear mostly in the later stages. If these later stages are not to be ratified until the previous ones have been achieved, technically Congress could withhold ratification at any stage.

(1) It appears to us essential that the Baruch proposals be amplified by making it clear that a definite succession of steps should be laid down from the outset and be accepted by each nation participating in the scheme. Each step is to come into effect upon a decision by the Atomic Energy Commission, or other agency of the United Nations, that the conditions laid down for the stage have been realized. In this respect, once the charter for the authority has been adopted, there should be no need for further ratification of each step by each country. The refusal by any member nation to implement these decisions would then be equivalent to a violation of the agreement setting up the Atomic Development Authority (A.D.A.).

(2) Notwithstanding the solemn undertaking already made by signatories to the United Nations Charter to refrain from all acts of aggression, it is not unreasonable to ask these nations in addition to reaffirm the undertaking with special reference to atomic weapons and all other weapons of mass destruction.

(3) Another point of difference is that the Russian proposals require the destruction, within a limited period, of existing stocks of weapons, whereas the American proposals would postpone this stage until an effective system of safeguards has been established. On this question it is easy to understand the reasons for either point of view, but we think it would be reasonable to ask at least for a declaration by all countries of the amounts of fissile materials in their possession and of the production-rates in existing or projected plants. Such a declaration might materially contribute to a spirit of confidence, while not appreciably impairing the security of the United States. We hope, in particular, that it may be possible to make these valuable materials available for productive uses rather than to destroy them. It is unlikely in any event that nations would agree to the destruction of the precious fissile materials, and without this the mere dismantling of existing bombs would be of no value, since the fabrication of bombs from the fissile materials is not likely to be the bottleneck in the production of weapons.

(4) If it is decided that the first step should consist of a complete survey and control of raw materials, it should be understood that during this first phase all nations should still be free to proceed with the construction of plants and the use, in such plants, of the raw materials accessible to them. The aim would be to submit these plants and any materials produced by them to the control of the A.D.A., at the same time as such control takes effect for the plants and stocks now existing in the United States.

(5) We believe that the chance of agreement and the rate of development of the beneficial uses would, in fact, be greatly improved if a generous view were taken of the definition of 'basic scientific knowledge' which can immediately be exempted from secrecy rules. We also suggest that it would be a generous and helpful gesture if the nations now possessing the most advanced knowledge of atomic energy were to offer to other nations collaboration in setting up small atomic reactors, which are of little use for military purposes but are valuable for the purposes of scientific research and for the production of tracer elements for research in medicine and other fields. Collaboration in the construction of such small reactors should not only consist in a transmission of the necessary data but also in exchange of scientific and technical personnel, and might involve the sale or loan of certain special materials of construction as far as the supply of such materials is available. This step, we believe, would offer immediate advantages to all the nations concerned which would far outweigh any contribution they make to the dissemination of technical experience of some value also for military applications.

B. Nature of Ultimate Control Scheme

(6) Turning now from the immediate action to the features of the ultimate control scheme, the point that has given rise to most controversy is the question of the veto. We think it unfortunate that this point should have reached such prominence in the early phase of discussion, before other features of the plans had been adequately considered. We believe that the relations of the A.D.A. to the rest of U.N.O., and in particular to the Security Council, have to be specified more clearly than was done in the Baruch proposals. It is clear that there cannot be two independent bodies responsible for the enforcement of international agreements, and that since the

* The final version of this memorandum was determined on November 28; it was supported by most members of Council of the Association, but two members felt unable to support the whole of it.

A.D.A. cannot supersede the Security Council, the A.D.A. has to be subject to the direction of the Security Council in matters of policy, and that A.D.A. cannot take upon itself the function of defining and punishing a violation of the agreement. As long as the U.N.O. charter provides for the right of veto in certain decisions of the Security Council, we do not see how the application of sanctions in matters which concern the A.D.A. can be made independent of this right. While definite provision for the veto exists and is likely to remain an essential part of the charter, it is, of course, essential that procedure be developed which limits the use of the veto to matters of fundamental importance without unduly hampering progress in the work of the Security Council. This point, the relevance of which is by no means limited to problems connected with atomic energy, is now being discussed by the permanent members of the Security Council.

(7) On the other hand, if A.D.A. is to carry out effectively the control of raw materials and is to own facilities for development and production, it will have problems of day-to-day management in which progress is impossible unless it possesses a certain degree of autonomy over such matters, which leaves it free to take decisions without referring each question back to the Security Council, and without the possibility of being blocked by a veto over technical matters. The line between administrative problems which are the province of the A.D.A. and policy problems to be settled by the Security Council is, of course, difficult to draw and, while rules can be framed after careful study of the situations likely to arise, there remain borderline cases in which the question of procedure will have to be settled by the Security Council, or possibly by the General Assembly of U.N.O.

(8) It is an important feature of the Baruch plan that all 'dangerous' production facilities, that is, all those that are easily adapted to the production of military weapons, should be owned by A.D.A. On this point the Gromyko plan makes no specific proposals, although points (2) and (3) of the terms of reference of the second committee proposed in that plan provide for discussions which might possibly lead to a scheme of the same general type.

What precisely is meant by 'ownership' is not very clearly specified, either in the Baruch plan or in the Lilienthal Report. Full ownership, in the usual sense of the word, would meet with difficulty, since it would give A.D.A. the right to decide whether power plants could be built in any country and the right to withhold the use of the power produced in such a plant or to place conditions on the supply of such power. Such restrictions would give the possibility of interference in the economic life of each country to a degree not essential to the purpose of preventing the abuse of atomic energy for destructive purposes. On the other hand, it would appear essential, in order to conform with the spirit of the Lilienthal proposals, that A.D.A. should take over the operation of such plants with the right of ensuring that any dangerous products were consumed in power plants and that no excessive stockpile be produced. We have no perfect solution to offer to this problem, but we feel that a careful study of the precise meaning of A.D.A. ownership should lead to a scheme that would be free from objections and that would provide both a safeguard against the accumulation of dangerous materials without the approval of A.D.A. and the opportunity for nations to take the initiative in building up within their territory efficient atomic power plants to supplement their other resources of power.

A scheme which, in this way, would circumscribe the powers of A.D.A. over national plants could minimize the difficulties arising from suspicion of interference with the economic structure of a country.

An alternative and less ambitious suggestion is to limit the function of A.D.A. to the inspection of plants and control over the distribution of products. In this connexion, however, we are impressed with the strength of the case made in the Lilienthal Report for giving to A.D.A. positive responsibility for production and ownership and with the difficulties outlined there of maintaining an effective inspection under any conditions. There is considerable doubt as to whether a control scheme not containing this feature would offer sufficient security.

(9) The positive functions of A.D.A. will be further strengthened if it is accepted that the Authority should itself undertake research on all problems of atomic energy. Its research organisations should be strong enough to ensure for A.D.A. a lead in knowledge of all scientific and engineering aspects of the problem and to make it desirable for most countries to call in its help in setting up and designing new plants. The existence of A.D.A. research organisations need not exclude national research, provided the latter is carried out openly and its results made available to A.D.A. In fact, the closest co-operation could be expected between the Authority and national research. At the very least, an A.D.A. research organisation should carry out the function of an essential clearing house of all information on the technical problems and should help to disseminate and co-ordinate the results of national research institutions.

(10) One of the key factors of control is that of raw materials, and here it is not sufficient to leave national initiative unimpaired, since in the absence of a free market the access to raw materials must be covered by international agreement. This problem is related to the general problems of access to raw materials other than atomic fuels; but it is outstanding among them because of the supreme military and future economic importance of atomic fuels. A solution to this problem should be sought in relation to the more general problem as well as in relation to the general agreement for the control of atomic energy.

(11) We do not believe that it is necessary to class research on atomic explosives as a dangerous activity; the danger does not come from research as such, but from the application of the results. The object of a control scheme is to ensure that the results of such research would never be used for destructive purposes; but, in addition to any engineering uses of atomic explosives, the knowledge of the possibilities of atomic weapons is essential to make effective plans for preventing their illicit manufacture or use. We believe that it would be a sufficient safeguard to ensure that research agencies not directly owned by U.N.O. should have no access to dangerous amounts of material, except under the supervision of A.D.A., and to require that all such research be carried out openly and that any relevant results be immediately reported to the A.D.A.

(12) A further important question is that of inspection. We have stated previously that the problem would be made easier if all dangerous plants were owned by A.D.A.; but there remains the problem of ensuring that they are indeed the only existing dangerous installations. If nations were prepared to rely on each other's good faith, the whole problem of control of atomic energy would not arise. As things are, they can feel secure only if there exists some form of inspection. It is desirable that the right of inspection should be circumscribed so far as possible and should not be a means of excessive prying into legitimate industrial or other activities. This is a question which can only be settled by extensive discussion. One might contemplate a procedure similar to a search warrant which would give the right of entry upon certification by A.D.A. that there exist reasonable grounds for suspicion. But one has to bear in mind that the discussion of the question whether in any given case there are reasonable grounds for suspicion may well lead to so much friction as to hamper seriously the work of A.D.A. We feel that the kind of inspection that merely aims at satisfying itself that any given mine or chemical plant is not handling large quantities of uranium or thorium ore, or that any given factory is not a separation plant or pile, is so different in type and order of magnitude from the kind of inspection that would disclose manufacturing secrets that it ought to be possible to work out a scheme which allows the one and prevents the other.

One key feature in preventing illicit production plants is the control of all natural uranium and thorium, and it seems to us essential that A.D.A. should have access to and control of all such material at the source. One cannot, however, rely on this measure exclusively on account of the possibility of some future discovery, such as an economic method of extracting uranium from low-grade ores, since in this way it might become possible to produce uranium as a by-product of other mining operations.

As a result of these discussions, it seems to us that the suggestions we have made ought to be considered as a basis of a workable scheme which in some measure surmounts the objections raised against the earlier proposals, and that, while they will no doubt have to be modified so as to adapt them to the views of the countries concerned, a discussion based on similar lines would give hope of finding a scheme that, of all possible control systems, has the greatest chance of being acceptable to everybody.

Conclusion

It must be admitted that an effective system of control acceptable to all concerned is a very doubtful proposition in the present state of distrust between nations, since it must contain, at least in embryonic form, a measure of world government. It is felt by some of our members that we can scarcely expect any effective agreement on the control of atomic energy at the present time. The above suggestions have been put forward in the hope that they will clear ideas with regard to a plan which we can only hope will be a feasible proposition before long. Some of the suggestions might, however, be put into effect immediately, mainly some of those we have listed under "A. Immediate Action". These might help in creating a favourable atmosphere for a workable system of control.

SILVER JUBILEE OF THE BRITISH CAST IRON RESEARCH ASSOCIATION

By J. G. PEARCE
Director of the Association

THE British Cast Iron Research Association was among the last of that early group of research associations to be established after the First World War, and, without departing from the basis of voluntary adhesion by interested and eligible firms, has raised its annual income from some £3,000 to last year's record of £40,000. The Association is concerned with the iron-founding industry, its raw materials, equipment, processes and products, together with their applications, and it endeavours to improve quality, facilitate manufacture and extend the uses of cast iron.

The material commonly termed 'cast iron' is, in fact, a range of iron–carbon alloys technically highly complex and readily differentiated from the steels, for they contain more carbon. Cast irons have an extraordinarily wide use in industry, including building and architecture, the engineering, chemical and metallurgical industries and domestic life. Before the Second World War, the industry had an output of some 2·5 million tons a year and employed about 100,000 people. It is anticipated that the demand will rise to 3·5 million tons by 1950. While cast iron is the cheapest of the ferrous alloys, its widespread use is due not only to low first cost and, under normal conditions, to comparatively rapid delivery, but also to the fact that for certain purposes it is unsurpassed. Engine crankshafts and camshafts constitute its most recent applications, for which it has proved highly successful. Foundry pig iron, the blast furnace product which forms the major raw material of the industry, is, metallurgically, a cast iron.

The properties of cast iron are determined in part by composition and in part by structure, which is not wholly determined by that composition. When the carbon in the metal remains combined as the hard, brittle carbide of iron, the resulting white iron casting has these properties. White irons can be annealed to give the product malleable cast iron, which is ductile. The bulk of the output, however, is of machinable grey cast iron, in which the task of the ironfounder and of the metallurgist is to adjust composition and section so that a small proportion only of the carbon remains combined, the balance being deposited as free carbon or graphite, usually in the form of microscopically visible flakes. In malleable cast iron the graphite is deposited in a nodular or spheroidal form known as temper carbon, and annealing in the solid state is the only way hitherto known of producing this structure.

Between the World Wars, iron-founding passed from the stage of craftsmanship to the possibility of scientifically controlled production, and as a result of investigations in various countries, notably Britain, the United States and Germany, the strength of cast iron was doubled. This was mainly accomplished by improving the metal matrix through reduced silicon and carbon contents, alloy additions, thermal treatment, and by better melting techniques and improved understanding of moulding sands. While the use of graphitizing ladle additions became

popular, giving more uniform graphite, its flake form remained unaltered. Remarkable advances were also made in the production of special-duty, as distinct from high-duty, or mechanically strong, cast irons for service conditions involving heat-, corrosion- and wear-resistance. The British Cast Iron Research Association, in exploring the causes of growth and scaling, evolved[1] the heat-resisting iron known as 'Silal', containing about 5 per cent silicon, and, later[2], the austenitic cast iron 'Nicrosilal'. Austenitic irons have found a number of industrial uses[3]. They are characterized by their relative ductility, non-magnetism, and corrosion- and wear- as well as heat-resistance. The mode of failure of ingot moulds for steel ingot, an exceptionally severe service, was also explored[4].

Ordinary cast iron has a mixed ferritic–pearlitic matrix, and the engineering irons are usually fully pearlitic. They may be annealed to the ferritic state for rapid machining. They may be stress relieved without structural change, or they may be submitted to quench and temper heat-treatments in the same way as the steels. To-day, practically any other desired structure, austenitic, martensitic or cementitic, of the metallurgical matrix can be made to predominate in cast iron. Furthermore, by alloying, a ferritic matrix can be made highly resistant to mineral acids, in the high silicon irons, and to heat and corrosion in the high chromium irons.

Development. Early in its life the British Cast Iron Research Association recognized the importance of accompanying the creation of new knowledge through research with means for its application in industry through what is conveniently termed 'development', and with means for its dissemination through information and intelligence. Development, in addition, covers treatment of a wide range of problems arising from technical and practical foundry difficulties, which keep the staff in close touch with the industry. Considerable improvements have been made in the cupola furnace, the industry's universally used melting unit. Of one type evolved by the Association, the balanced blast cupola, more than three hundred have been installed, with an aggregate melting capacity of 2,400 tons an hour, half in Great Britain and the remainder in some twelve countries overseas. The development side is actively concerned with casting design, that is, the economical disposition of material. During the War it dealt with the anti-glare problem for the industry's furnaces, together with the technical aspects of the fuel situation. A number of research contracts were also carried out for official departments.

The research and development staffs are aided by a group of specialized laboratories, chemical, spectrographic, physical, metallographic, mechanical testing, sands and refractories, as well as by an experimental foundry.

Research. The research programme can be divided roughly into two parts. The first comprises what Sir Edward Appleton has aptly termed "objective fundamental research", that is, exploratory work designed to increase background knowledge for the industry served by the Association. The second part comprises investigations aiming at specific and clearly defined ends, either necessary to the fundamental programme or needed by the industry. To illustrate this section, reference may be made to the evolution and evaluation of new and improved methods of testing and control, and the application of new instruments and apparatus to the materials and processes of the industry. The metallurgical complexity of cast iron—the number of elements involved is never less than six and may reach twice that number—makes this a difficult task. Methods of testing and control of moulding sands and other foundry materials, methods of testing and specification of the product, wet analytical methods, application of the spectrograph and the photo-electric absorptiometer, have all been covered. For the future, X-ray diffraction, the electron microscope, radiographic and gamma-ray examination for defects, supersonic testing, polarographic and micro-chemical methods must be considered. Much *ad hoc* work comprises the determination of mechanical and physical properties needed by the engineering designer at ordinary, sub-normal and elevated temperatures[5]. Early work in this connexion has included the rationalization of the widely used transverse test for cast iron and the relationship between toughness of the material and the plastic component of transverse deflexion[6]. Various grades of grey cast iron can be obtained to national specifications in British Standards Specifications 321 and 786.

It is necessary to confine a brief review to metallurgical work, and as an illustration of work on the fundamental side the mechanism of graphite formation may be chosen. This has been pursued over a period of years, interrupted by the War, in the conviction that the fullest potentialities of cast iron can only be realized if the size, form and distribution of graphite can be controlled, and that such control can only derive from an understanding of the mechanism of formation.

Graphite formation. The characteristic flake form in grey iron and the temper carbon or nodular form in malleable cast iron have been mentioned. Another form of very finely divided graphite was known, although the circumstances of its formation were obscure. It was established, however[7], that this form was encouraged by allowing the melt to undercool, and it is therefore called 'undercooled graphite'. Later it was found that flake and undercooled graphite formed in melts of otherwise similar composition were produced by varying the conditions of melting[8], which were more important, in fact, than composition variations. A major step forward took place when the undercooled form was produced at will from a melt that would otherwise solidify in flake form, by ensuring the presence of a small amount of titanium in the melt, and treating it while molten with carbon dioxide[9]. Structures exclusively composed of undercooled graphite were produced in cast iron which without treatment conformed to the ordinary flake pattern, and which could be made to revert by treatment of the melt with hydrogen. This work gave considerable impetus to the theory that flake graphite formed on pre-existing non-metallic oxide or silicate inclusions, but direct microscopic examination revealed that pig and cast iron showed no traces of such oxides or silicates[10], while chemical examination gave values too small to support any superstructure of theory[11]. It was, in fact, shown that pig and plain cast irons are more free from oxides and silicates than the steels, while the only non-metallic inclusions of consequence comprised the sulphides. A recently published study has confirmed this[12] in respect of the alloyed cast irons containing nickel, copper, chromium, molybdenum and other elements. These

results directed attention to the influence of gases and to a more fundamental examination of the position.

In recent years the theoretical metallurgist and the physicist have done much work in studying elements related in the Periodic Table and in electronic structure. The value of the predictions of the physicist has been realized and studies were made of the nickel–carbon and cobalt–carbon alloys to see whether their behaviour would throw any light on the iron–carbon alloys as exemplified in the cast irons. The results of the work of Morrogh and Williams are being published by the Iron and Steel Institute, and embody a complete statement of the phenomena which require to be explained by a comprehensive theory of graphitization. In addition, the work provided the necessary lead towards the production of nodular graphite in as-cast material; and since the completion of this report it has proved possible to obtain nodular graphite in cast iron as also in the nickel–carbon alloys.

Although the nodular graphite produced directly in the mould resembles that obtained in malleable cast iron, the new structure does not have the properties of malleable cast iron (for example, as in British Standards Specifications 309 and 310), which has a comparatively low carbon content and the advantages of a lengthy homogenizing anneal. Nevertheless the new structure does have a small but measurable elongation and area reduction, together with static tensile and transverse properties and impact strength double or treble those of the same material in the untreated state. In fact, ordinary hæmatite pig iron can be melted and treated to give the mechanical properties of what are now regarded as high-duty cast irons. Thus, a hæmatite iron gave, in the untreated and treated states, tensile strengths of 15·5 and 26·5 tons per square inch, transverse strengths of 29·4 and 47·9 tons per square inch, and impact strengths of 13 and 47 ft.lb. (a British Standards Specification for the cast iron impact test is pending) respectively. In a 4·0 per cent carbon hæmatite, of one hundred bars cast, ten chosen at random had their tensile strengths between 23·8 and 24·3 tons per square inch, and Brinell hardness numbers between 198 and 203, indicating a very high degree of uniformity.

The presence of phosphorus in foundry pig irons makes the influence of this element of particular importance in practice. Phosphorus up to the amounts studied does not interfere with the new structure, although in high-phosphorus irons, the phosphorus must be expected to exercise its dominating effect on strength.

The austenitic irons lend themselves well to the new treatment. A 'Niresist' of 10 tons tensile and 30 ft.lb. impact strength gave, on treatment, a tensile strength of 20–25 tons per square inch and 120 ft.lb. (unbroken) impact. A 'Nicrosilal' iron in the untreated and treated states gave a transverse deflexion of 0·75 in. and 3·5 in. (unbroken) respectively.

These preliminary results require amplification before a more complete statement is possible; but there is little doubt that this is the most significant advance in the metallurgy of cast iron in the present century, and that the new material will lift ordinary cast iron to a new plane, as well as forming a base for the production of still stronger high-duty irons. The pursuit of this work, both in respect of its theoretical basis and its industrial application, must form a major item in the Association's future programme.

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TIMIRIAZEV, FOUNDER OF SOVIET GENETICS

By Dr. G. H. BEALE
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KLIMENT ARKADIEVICH TIMIRIAZEV is to-day regarded by Soviet botanists as one of their chief authorities, mainly on account of his life-long support for Darwinism. In Great Britain, however, his work is but little known, apart from a few references in text-books of plant physiology. We are therefore interested to see L. S. Tsetlin's short account of Timiriazev's life and work[1], which has recently appeared in the Soviet Academy of Science's popular scientific series of biographies. Having read this book, one can well appreciate why the name of Timiriazev is now so highly esteemed in the Soviet Union.

Kliment Arkadievich was born in 1843 in St. Petersburg. His father, a government official, came of an ancient Russian noble family; but, we are told, "held republican views, and had a revolutionary temperament"; his mother was English, and no doubt it was from her that he acquired his great interest in England. Already at the age of fifteen, in order to earn money, he was daily reading *The Times* for a Russian paper, and translating Dickens and other English novelists into Russian. He remained an Anglophile all his life. He is quoted as having said: "Of all civilised nations, the English are the most remote from scientific conceit and pedantry", and "it was no accident that it was amongst the great English people that there appeared a thinker who has made evolution the corner stone of modern thought".

Timiriazev was elected a foreign member of the Royal Society in 1911, eight years after delivering the Croonian Lecture; and it was not only British science which he admired, for he is reported to have expressed a fondness for the English landscape, and the paintings of Constable, Gainsborough and Turner.

In 1861, Kliment Arkadievich entered the University of St. Petersburg but was soon obliged to leave, on account of student unrest, and he finished his course in 1866 as a private student in natural sciences. This was the time of the liberation of the serfs in Russia, and Timiriazev states that the

enthusiasm for progressive movements which he gained during the 'sixties remained with him for his whole life.

After spending two years abroad, in Heidelberg and Paris, he was appointed in 1870 a teacher (later professor) at the newly founded Petrovsky Academy of Agriculture and Forestry in Moscow (now the Timiriazev Academy), and engaged in teaching and research in plant physiology until 1892, when he was expelled. From 1877 he was also a professor of plant physiology in the University of Moscow, until 1901, when he was likewise excluded from its professorial body. Evidently his views on "free scientific thought, freedom of instruction, and autonomy of places of higher education", did not accord with those of the educational or ecclesiastical authorities, and consequently he was never made a full member of the Imperial Academy of Sciences.

In 1909, Kliment Arkadievich had an apoplectic fit, and became paralysed. However, he retained possession of his mental faculties for another ten years. He died in 1920.

Apart from some early work in 1867 on the effect of mineral fertilizers on rye and oats, practically all Timiriazev's research was concerned with photosynthesis. Thus he made some experiments on the relative effects of different parts of the spectrum on photosynthesis, and attempted to prove, in accordance with his materialist views, a proportionality between photosynthesis and the amount of energy absorbed by the plant in the form of light.

Timiriazev's views on plant physiology are summarized in a book called "The Life of the Plant", an English translation of which appeared in 1912. The material for this book was originally taken from a course of lectures delivered in 1876 in Moscow, and embraces a wider range of topics than is now included in plant physiology. The first chapter is called "Science and Society", in which Timiriazev expresses the view that "the physiology of plants will develop in the schools of agriculture in the same way as the physiology of animals developed in the schools of medicine", and "obviously the physiology of plants must be made the foundation of agriculture". In these views Timiriazev was many years ahead of his times. In the last chapter, devoted to the "Origin of Organic Forms", he states: "naturalists hail Darwin's theory as the crowning of the stately structure of modern physiology".

In 1864, five years after the appearance of Darwin's "Origin of Species", Timiriazev published an article entitled "Darwin's Book, its Critics and Commentators", and from that time until the end of his life never ceased to be an enthusiastic propagandist for Darwin. Timiriazev's "Struggle for Darwinism" (as L. S. Tsetlin calls it) took the form, in the main, not of original observations and experiments, but of polemics with various of his compatriots. The two principal Russian anti-Darwinians were (1) N. Ya Danielevsky (1822–85), "one of the reactionary epigones of slavophilism", who published in 1885 and 1889 two massive volumes purporting to reduce Darwinism to an "amorphous heap of rubbish", and (2) N. N. Strakhov (1828–96), a "naturalist philosopher and publicist". Timiriazev also ventured to differ, with respect, from the great Tolstoi, who in his novel "Anna Karenina" and elsewhere had attacked the principles of natural selection. Such criticism of Darwin in nineteenth-century Russia, based on nationalism, ethics, or a non-materialist philosophy, is now, however, of little scientific interest in comparison with the violent controversies which raged after the re-discovery of Mendel's famous paper in 1900.

On the subject of Mendelism, Timiriazev expressed himself with characteristic vigour. Thus, in the prefaces to the fifth, sixth and seventh edition of his book, "Charles Darwin and his Work" (1905, 1908, 1919 respectively, and reprinted in 1941), Timiriazev writes [reviewer's translation]:

"I demonstrated the failure of the attempts to refute Darwinism by the clerics and metaphysicians, and, in Germany, by the nationalist Chauvinists. The ungifted, obstinate Bateson has continued to act as leader of the clerical anti-Darwinian movement in England. . . . As is known, he has greatly exaggerated the significance of Mendel's work, endeavouring to obscure the importance of Darwinism with the over-inflated glory of a catholic monk", and so on.

Notwithstanding this onslaught, it is of great interest to note that Timiriazev at the same time saw no inconsistency in pointing out certain virtues in Mendelism. Before the discovery of Mendel's laws, the theory of natural selection had been exposed to criticism on account of the then widely held assumption of blending inheritance. Thus Fleeming Jenkin, professor of engineering in the University of Edinburgh, had, in 1867[2], pointed out that if a plant or animal should arise, deviating by an amount n from the normal, then, with cross-fertilization, members of the next generation would show a deviation of only $n/2$, and the next after that only $n/4$. Consequently, there would be a 'swamping effect' on every newly arising variation, and the chance of natural selection acting on such variations would be extremely slight. (This has been pointed out in more recent times by Fisher in "The Genetical Theory of Natural Selection".) Apropos of this, Timiriazev, in a speech delivered in 1909[3], fifty years after the publication of the "Origin of Species", said:

"The answer to Jenkin's objection was given already two years before the appearance of his article. In 1865, a completely unknown Augustinian monk named Mendel published a paper . . . showing that characters do not blend, but are preserved unchanged, and are distributed between various descendants. . . . *Thus, Mendelism removes the most dangerous objection which, in the words of Darwin himself, was made against his theory*".[3] [My italics.]

It is greatly to his credit that Timiriazev should here put aside his anti-Mendelian prejudices, which were doubtless due partly to his dislike of religion in general and consequently of Mendel for his clerical association, partly to the fact that Mendelism was taken up in a distorted form by the German so-called race theorists, and partly again to the hostility towards natural selection felt by Bateson and other Mendelian enthusiasts.

Timiriazev's incorporation of Mendelian segregation into the theory of natural selection is correct according to the views of modern genetics. It is, however, contrary to the teachings of the Lysenko[4] school, at present dominant in the U.S.S.R., and Lysenko is described by Tsetlin as Timiriazev's "ideal pupil". It is therefore the more regrettable that Tsetlin in his book fails to direct attention to this inconsistency, and merely points out that "Timiriazev acknowledged Mendel's undoubted merit".

As is well known, Darwinism has been accepted as part of the official *Weltanschauung* of the U.S.S.R. Karl Marx, writing to Engels in 1860 about the

"Origin of Species", said: "This book gives a natural-historical basis to our views", and since then the parallelism between "Das Kapital" and "The Origin of Species", which appeared within eight years of each other, has often been drawn. Tsetlin adds: "in widely spreading propaganda for Darwinism, Timiriazev was preparing among his numerous pupils and readers a favourable soil for the planting of dialectical materialism".

Shortly before Timiriazev's death in 1920, there appeared a volume of his more political writings, collected under the title "Science and Democracy", in which he welcomed the Bolshevik regime. For this he received a letter of hearty thanks from Lenin himself.

Tsetlin, in the preface to his book, states that his purpose is to follow the progress of Timiriazev's views "from bourgeois democracy to communism, through the medium of his own particular science". A good case is certainly made out for this; but it is a pity that Timiriazev is misrepresented in at least one important respect (that is, concerning Mendelism). Indeed, Kliment Arkadievich Timiriazev was, in the view of the present writer, a greater man than perhaps appears from Tsetlin's book.

[1] Timiriazev, by L. S. Tsetlin, U.S.S.R. Acad. Sci., 1945. Pp. 153 (in Russian).
[2] *North Brit. Rev.*, June, 1867.
[3] I have translated this passage from p. 207 of the 1941 edition of Timiriazev's book, "Charles Darwin and his Work".
[4] See Ashby, E., *Nature*, **158**, 285 (1946).

OBITUARY

Prof. F. M. Rowe, F.R.S.

FREDERICK MAURICE ROWE, born at Stroud, Gloucestershire, in 1891, died at his home in Leeds on December 8. One of a long line of Clothworkers' Scholars from Marling School, Stroud, he entered the Department of Tinctorial Chemistry and Dyeing of the University of Leeds in 1908, graduated with first-class honours in tinctorial chemistry in 1911, and was president of the University Union during 1911–12.

After a period of research with Prof. A. G. Green on nitrohydrazo compounds and *o*-nitroamines, Rowe joined the research staff of Messrs. J. Crosfield and Sons, Ltd., of Warrington, in 1913, and was sent to study colloid chemistry with Freundlich at the Technische Hochschule, Braunschweig, Germany. In 1916, however, he resumed his association with Green, who had been appointed director of the newly established Dyestuffs Research Laboratory at the College of Technology, Manchester. Two years later, he became head of the Laboratory, where he remained until 1926. During this period, the work on *o*-nitroamines was continued, and the properties of certain azo dyes derived from hydrogenated naphthalene derivatives were investigated. He also examined tars obtained from the low-temperature carbonization of coal, and elucidated the constitution of certain yellow pigment colours, for example, the Hansa Yellows, and the composition of some rapid fast printing colours and products used in the production of insoluble azo colours. For these and other investigations he was awarded the degree of D.Sc. by the University of Leeds in 1921, and the fellowship of the Institute of Chemistry in the same year.

This was a period of re-birth for the dyestuffs industry of Great Britain and, conscious of his special responsibilities to the industry, Rowe accepted the invitation of the Society of Dyers and Colourists to undertake the heavy task of compiling and editing an authoritative work of reference on colours, their composition, method of manufacture, properties and uses. The "Colour Index" was the result, and of all Rowe's achievements it is the one most closely associated with his name. He was awarded the Gold Medal of the Society of Dyers and Colourists in 1934 in recognition of his "exceptional services to the Society and to the tinctorial industries as Editor of the *Colour Index*, 1924, and the *Supplement*, 1928".

After being appointed reader in tinctorial chemistry at the College of Technology, Manchester, in 1925, Rowe was elected to the chair of colour chemistry and dyeing at the University of Leeds in 1926, on the retirement of the late Prof. A. G. Perkin. His subsequent research was in two main fields. The first arose out of the observation that phthalazine derivatives are formed by the action of excess sodium hydroxide on the diazosulphonate derived from diazotized *p*-nitro-aniline and β-naphthol-1-sulphonic acid. On extending the work to diazosulphonates derived from other nitroamines and their derivatives, results of such interest and importance were obtained that the series of papers increased to twenty-five, some of which, though written, await publication. In addition, he undertook research on the preparation and properties of intermediates for dyes and related products.

The second main line of investigation was concerned with the application of dyes, and ranged over a wide field. Among the subjects studied were the effects of after-treatment on the aggregation, location, shade and fastness properties of insoluble azo dyes on the fibre; the reduction and dispersion of azoic dyes in presence of Lissolamine A; and the fading of dyeings on cellulose acetate rayon, due to the action of oxides of nitrogen in the atmosphere. In later years, particular attention was paid to the dyeing of wool with chrome mordant dyes. Starting with a study of the peculiar dyeing properties of wool which had been exposed to the action of light and air, the work was extended to include fundamental work on the chroming of wool and an exhaustive study of the metachrome process.

Rowe's distinction as a research worker was recognized by the award of the Worshipful Company of Dyers' Research Medal on five occasions, and by his election to the fellowship of the Royal Society in 1945. He was admitted to the livery of the Worshipful Company of Dyers in 1932, and to the honorary freedom and livery of the Worshipful Company of Clothworkers in 1944. Such distinctions were the reward of a life characterized by a high sense of duty: duty to his students, whose subsequent careers he followed with close personal interest; duty to the University, where his wise counsel will be sorely missed in a period of reconstruction and development; and duty to the industry, of which he was the academic focus. It was typical of the man that, despite these many responsibilities, he should accept a commission in the Home Guard at the time of its formation. The accumulated burden was then too great, and his health gave way in 1943. Yet indomitable courage enabled him to continue academic work to the very end of his days.

E. J. CROSS
J. B. SPEAKMAN

NEWS and VIEWS

Physics at Middlesex Hospital Medical School: Prof. Sidney Russ, C.B.E.

PROF. SIDNEY RUSS, as announced in *Nature* of January 4, has recently retired from the Joel chair of physics, attached to the Middlesex Hospital Medical School, and been appointed emeritus professor of physics in the University of London. Prof. Russ was the doyen and one of the most distinguished members of the group of hospital physicists who have played an important part in developing the science of medical radiology. After a brilliant career as an undergraduate at University College, London, he was appointed demonstrator in physics at the University of Manchester. Here he became one of Rutherford's earliest research associates, and with the late Prof. W. Makower investigated the phenomenon of the recoil of atoms undergoing radioactive disintegration. His interest in radiology led to his appointment in 1910 to a Beit Memorial Fellowship tenable at the Middlesex Hospital, a connexion with this institution which remained unbroken until his retirement in September last. On the expiry of his fellowship he was appointed physicist to the Hospital, and later, in 1920, was appointed to the first chair in physics at a London medical school.

As an investigator and administrator, and also as a lecturer possessing great charm and lucidity, Prof. Russ has exerted a considerable influence on medical radiology. Probably his most notable contribution to the subject is the book which he published in collaboration with the late Dr. H. A. Colwell entitled "Radium, X-Rays and the Living Cell". This pioneer work attracted many to this field of investigation and stimulated the interest of a much wider circle. Later, again in association with Colwell, he published another work, "X-Rays and Radium Injuries", and was joint author with his colleagues, L. H. Clark and B. D. H. Watters, of the well-known "Physics in Medical Radiology". He also contributed a succession of original papers on the influence of radiation on living cells, organs and tumours. In addition to being honorary secretary of the Radiology Committee of the Medical Research Council, the first scientific secretary to the National Radium Commission, and radium adviser to the King Edward Hospital Fund, Prof. Russ was for many years a member of the British X-Ray Units Committee and of the British Committee for X-Ray and Radium Protection. The present international recommendations relating to X-ray units and to radiation protection are largely based on the work of the British Committees and owe much to Prof. Russ's knowledge, zeal and wisdom.

Prof. J. E. Roberts

DR. J. E. ROBERTS, who has been elected to fill the Joel chair of physics at the Medical School of the Middlesex Hospital, University of London, is a graduate of Leeds. He has for some years been associated with hospital physics mainly in connexion with radiotherapy. His work with Prof. W. V. Mayneord at the Royal Cancer Hospital resulted in his appointment about ten years ago to the Middlesex Hospital. His main research in the field of pure physics has been an attempt to formalize the energy distribution in the gamma-ray spectrum of radium B and C.

American Association of Physics Teachers: Award of Oersted Medal

THE Oersted Medal of the American Association of Physics Teachers has been awarded to Prof. Duane Roller, professor and head of the Department of Physics of Wabash College, Crawfordsville, Indiana. The award is made annually "for notable contributions to the teaching of physics". Through the *American Journal of Physics*, which he has edited since it was founded in 1933, Prof. Roller had made a notable contribution to the teaching of physics at the college and university levels. Prof. Roller was educated at Culver Military Academy and at the University of Oklahoma. He was later, for thirteen years, on the staff of the University of Oklahoma, during which period he received a doctorate at the California Institute of Technology. Afterwards he became a research associate at Columbia and an associate professor at Hunter College. During the First World War he was a pilot, and during the Second World War he was chief technical aide of the National Defense Research Committee. The formal award will be made at the annual meeting on January 31 of the American Association of Physics Teachers, to be held at Columbia University. In his address of acceptance Prof. Roller will discuss one of his chief professional interests, physical terminology, another field in which he has made notable contributions, both to the teaching of physics and to the science itself.

British Medical Journal: Retirement of Dr. Gerald Horner

THE news that Dr. Gerald Horner retired under the age limit from the editorship of the *British Medical Journal* at the end of 1946 will be heard with regret by all those who have benefited, during the last nineteen years, from his able editorship. The editing of a leading medical journal, which is also the official organ of the British Medical Association, has always been a high responsibility. During recent years it has carried with it an increasing preoccupation with the health and well-being, not only of the people of Great Britain, but also with that of great and harassed populations elsewhere. If, indeed, we seek a measure of the achievement of Dr. Horner, we shall find it in the fact that the whole world looked to the *British Medical Journal* for guidance and leadership.

Formerly an assistant editor of the *Lancet*, the staff of which he joined in 1911, Dr. Horner became editor of the *British Medical Journal* in January 1928. Under his editorship the circulation of the journal has increased so considerably that he cannot but have felt, when he left the editorial chair, that his labours have been well rewarded. It has fallen to his lot to edit the journal throughout the very difficult period of the recent War, when the paper shortage, air raids and a multitude of other difficulties coincided with the necessity of providing, every week, a journal well filled with news and informative and research articles. Among the latter were the records of noteworthy results of British war-time research; and their publication and the issue of a great deal of other information was an essential part of our war-time effort. How efficiently Dr. Horner discharged this task is well known; as are also his kindly and helpful influence and personality. During the later months of his editorship, the British Medical Association planned and launched

no less than eight new specialist medical journals, each with its own editor. His experience must have been an invaluable aid in the planning of these additions to medical literature. His advice must have been essential also to the successful planning of the two new abstracting journals which began publication by the British Medical Association this month under the general direction of the editor of the *British Medical Journal*. These new journals, namely, *Abstracts of World Medicine* and *Abstracts of World Surgery, Obstetrics and Gynæcology*, are modelled on the *Bulletin of War Medicine*, which under the able editorship of the director of the Bureau of Hygiene and Tropical Diseases, Dr. Charles Wilcocks, and the publications officer of the Medical Research Council, Dr. F. H. K. Green, gave, until its publication was discontinued in 1946, so remarkable an epitome of medical work during the War.

Dr. Hugh Clegg

DR. HORNER has done a great work. It will be a satisfaction to him—and to everyone else—to know that the journal which he has so ably edited will now be in the hands of Dr. Hugh Clegg, who has been, since 1934, assistant editor. Dr. Clegg brings to his task a vigour of character, a broad outlook and an experience of medical journalism which make it certain that the great traditions of the *British Medical Journal* will be maintained. Everyone will wish him success in a work which may well have, during the period upon which we are now entering, a greater influence upon the health of the public and of the individual than medical journalism has ever had before.

Biology and Human Affairs

THE autumn issue of this useful journal maintains the high standard that teachers of biology and others interested in the broader aspects of biology (including social biology and human affairs) have now come to expect. Edited and produced by officers of the British Social Hygiene Council, the journal has also the advantage of a strong board of editorial consultants—Profs. F. A. E. Crew, J. Ryle, T. H. Pear, S. Zuckerman, and Dr. A. I. Richards, Mrs. E. M. Hubback and Mr. L. G. Troup.

The current number deals with science and ethics as a follow-up of the Conference on Science and Ethics organised by the British Social Hygiene Council last July. E. J. H. Corner, of the Botanic Gardens, Singapore, contributes a stimulating article dealing with tropical biology as an international problem. Sir John Megaw discusses over-population as a world problem. Sir John gives much food for thought, especially when discussing the possible effect on population problems of the World Food Plan envisaged by the Food and Agricultural Organisation. The report of the Council's Summer School held at Wadham College, Oxford, reveals the value that teachers and local authorities are attaching, to an increasing extent, to these gatherings. An informative article on the biology of twins is contributed by F. Whitwam Jones; and one on democracy and museum zoology by the keeper of zoology, National Museum of Wales (Colin Matheson), is provocative and suggestive. Book reviews play an important part in this journal—an excellent publication which should be read by all biologists interested in the teaching and social implications of their subject, and especially by school teachers. It is published by the British Social Hygiene Council, Tavistock House North, Tavistock Square, London, W.C.1.

New Scientific Journals

THE newly founded Society for General Microbiology is to issue the first number of its journal—the *Journal of General Microbiology*—during January (Cambridge University Press). The journal will be edited by B. C. J. G. Knight and A. A. Miles; the associate editors are G. C. Ainsworth, W. B. Brierley, T. Gibson, A. T. R. Mattick, Kenneth Smith, A. W. Stableforth and D. D. Woods. For the time being there will be three numbers a year, the annual subscription being 50*s*. Further information can be obtained from the Cambridge University Press, Bentley House, 200 Euston Road, London, N.W.1.

The Nutrition Society is also to produce a new journal—the *British Journal of Nutrition*—which will be issued quarterly. It is hoped to publish the first number during the first half of 1947. The editorial board is as follows: D. P. Cuthbertson, J. N. Davidson, R. C. Garry, G. Graham, J. Hammond, E. M. M. Hume, S. K. Kon (chairman), I. Leitch, W. C. Miller, B. S. Platt, J. A. B. Smith and F. Yates. This journal is also to be published by the Cambridge University Press, from which further particulars can be obtained.

British Association

SIR HENRY DALE, who succeeded Sir Richard Gregory as president of the British Association on January 1, was formally installed at a meeting held at Burlington House on January 3, and addressed a joint meeting of sectional committees assembled to consider the programme for the meeting of the Association in Dundee next autumn. For the first full post-war meeting of the Association, the Council has adopted a general theme 'Swords into Ploughshares', and prominence will be given in the programmes to papers and discussions on the positive contributions which science has made, and can make, towards the well-being of mankind.

Carnegie United Kingdom Trust

THE thirty-second annual report of the Carnegie United Kingdom Trust, for the year ended December 31, 1945 (from the Trust, Dunfermline), states that the Trustees have decided to revert to the pre-war system of arranging the business of the Trust in certain main groups, and for this purpose have reconstituted standing sub-committees of the Executive Committee dealing, respectively, with arts, community services, education, youth services and finance and general purposes. The accounts of the Trust, which are now again printed as an integral part of the report, show a total expenditure on grants of nearly £75,000 or about £3,500 more than in 1944. Of this, £30,343 is for youth services, £23,733 for community services, £10,634 for the arts and £8,731 for education. The expenditure for youth services was represented chiefly by capital grants in aid of equipment of youth clubs and hostels, but the Trustees have decided against an extension of the bursary scheme for training men for club leaders and in favour of assisting the National Association of Boys' Clubs to provide a residential institution for standardized training. Another grant of £10,500 was made to the Warwickshire Rural Community Council towards the acquisition, equipment and furnishing

of Westham House, Barford, as a Town and Country College to bridge the present and ever-widening gap between townsman and countryman. The Trust has continued to meet the whole cost of maintaining the Irish and Scottish Central Libraries for Students and has maintained its grant in aid of the National Central Library.

The concluding part of the report deals with the plans of the Trust for the quinquennium 1946–50, and a statement of policy forms an inset to the report. The oldest of the major policies of the Trust still extant at the outbreak of war was that of assisting the provision and improvement of village halls. At the date of the review 585 such schemes had been assisted, and the Trustees propose to allocate a further £100,000 for this purpose during the next five years. An allocation of £30,000 for museum services is also proposed, and £150,000 for a comprehensive music and drama policy, to administer which the Carnegie Committee for Music and Drama has been established. While the Trustees are terminating the scheme of making grants in aid of the equipment of local youth clubs, they propose to allocate £40,000 towards the equipment required for residential purposes in youth hostels and camps under detailed conditions, and as an exceptional measure £25,000 has been set aside to help the National Federation of Young Farmers' Clubs to bridge the transitional period between the present system of direct grant from the Ministry of Education and the new system of grants from local education authorities. Provision of a sum of £150,000 is also proposed towards the establishment and maintenance of the Bureau of Current Affairs to provide for the general populace the kind of information service given during the War by the Army Bureau of Current Affairs and the Civil Defence Welfare Services. The inset already mentioned gives the addresses where inquiries regarding particular activities should be made.

Degaussing

THE October number of Part 1 of the *Journal of the Institution of Electrical Engineers* (Vol. 93, No. 70) contains three papers which were read at the first session of a symposium on degaussing held during April 4–5, 1946. The first paper, by H. W. K. Kelly, gives a historical survey of developments prior to the start of the campaign against the magnetic mine. The others, by D. H. Parnum and R. J. Gossage, deal respectively with underwater measurements of magnetic field, and the use of ship models, magnetically to scale, in degaussing work.

The November issue of the *Journal* contains four papers on the same subject. The first, by W. C. Potts, surveys the study of the magnetic fields produced by ships constructed during the war period, and indicates, schematically, how degaussing coils were placed for the purpose of neutralization. The electrical engineering aspects of these arrangements are then discussed in detail in a paper by Messrs. I. S. Fraser, A. A. Read and B. E. Vieyra. A further paper, by S. H. Ayliffe, describes alternative measures to that of coiling used as means of affording protection, namely, the processes known as 'wiping', 'flashing' and 'deperming'. The first of these processes was developed mainly for the purpose of providing compensation for the vertical magnetism of those ships which have insufficient power to energize a coil system. That of 'wiping' is based on the principle of magnetizing ferrous materials by stroking with a magnet or current-carrying conductor, and consists in practice of wrapping a cable temporarily around the vessel in the horizontal plane and moving it up and down while a heavy current is passed through it; while that of 'flashing' consists in surrounding the vessel with a horizontal cable near the water line and in passing a heavy current through it momentarily. The term 'deperming' is used to cover any form of treatment, to which the vessel is temporarily subjected, designed to remove or compensate permanent longitudinal or athwartships magnetism. In its final form, the process involved wrapping the hull with a cable solenoid through which short-duration current pulses were passed. Finally, a paper by Messrs. H. C. Wassell and D. A. Turner discusses the effect exercised by degaussing coils on ships' compasses and describes the compass-corrector equipment which was developed. The publications are followed by a summary of the discussion at the Institution and the authors' replies (see also *Nature*, May 18, p. 646).

Metallurgical Research

VOL. 71 (1945) of the *Journal of the Institute of Metals* contains the report of the Council, which shows a total membership of the Institute of 2,686. Twenty-eight original papers are included, together with discussions, and occupy 654 pages. It is of interest to note how large a proportion of the volume deals with the light metals and their alloys, papers on magnesium and aluminium representing about half the total number. Copper and its alloys are dealt with in some half-dozen papers, which include a valuable contribution on the "Computation of Rolling Load, Torque, and Roll-Face Pressure in Metal Strip Rolling" by Dr. M. Cook and E. C. Larke. Three papers refer to the precious metals, while constitutional work (always an important section of the Institute's interests) is dealt with in six. The May Lecture by Sir Thomas Holland dealt with "The Supply of Accessory Metalliferous Minerals", and Dr. R. Seligman discusses "The Organisation of Metallurgical Research". An interesting account is given by Mr. H. A. Sloman of "The Application of the Vacuum-Fusion Method to the Determination of Oxygen, Hydrogen and Nitrogen Contents of Non-Ferrous Metals, Alloys and Powders". The corrosion of metals, as one expects, is dealt with in more than one paper. To those familiar with this *Journal*, all that need be said is, that it fully maintains the high standard of previous issues, a standard which in view of the present difficulties is eminently praiseworthy. The plates, of which there are forty-seven, are excellently produced.

Vol. 12 of "Metallurgical Abstracts" follows the lines which we now expect. 424 pages of abstracts and 88 of indexes give an idea of the care with which the ground is covered. To the metallurgist, both theoretical and practical, as well as to chemists, physicists and engineers, these volumes have become essential.

Test Papers for *p*H Values

WE have received from Messrs. Johnson and Sons, Manufacturing Chemists, Ltd., Hendon, London, N.W.4, samples of two kinds of test papers. These are made up in small books like litmus papers. The Universal Test Paper for the measurement of *p*H values provides ten colour matches in steps of 1 *p*H from 1 to 10, with an accuracy of 0·5 *p*H, the appropriate colours being printed inside the covers of each

book. The Comparator Test Papers provide a higher degree of accuracy, to 0·3 *p*H, inside narrower ranges, in four kinds from *p*H 3·6 to *p*H 10, the colours being again printed inside the cover. The papers can be dipped into the solution, or the latter applied by a glass rod. We have tested both kinds of papers with buffer solutions and have found the colour changes to be as stated. They should be very useful to chemists, biologists, physicians, and workers in various industries, when a rapid and reasonably accurate method of measuring *p*H is desired. Messrs. Johnson also make a wide range of other test papers and supply a special grade of litmus in the form of granules free from the usual fillings of gypsum or calcium carbonate and requiring only extraction with water to produce an indicator solution. The firm is investigating supplies of lichens from various parts of the world in attempts to produce a high-quality litmus. It is interesting to note that the firm was established so long ago as 1743.

Plant Health in the Argentine

Prof. J. B. Marchionatto has prepared a study of plant health in the Argentine from the colonial period in 1810 down to 1943. (Fac. Agron. y Vet., Univ. Buenos Aires). It is divided into four parts, the first of which is almost entirely historical, giving a description of the development of plant life and also a short account of the work of some of the outstanding men who have devoted their time to this subject. The second part describes the conditions in the Department of Agriculture when Prof. Marchionatto took charge of the Laboratory of Plant Pathology. It also includes a survey of the work that was carried out between 1923 and 1932, when the Division of Phytopathology was formed; Prof. Marchionatto's small laboratory was moved to the new Division, and in 1935 was transferred to the Bureau of Plant Health. Part 3 deals with the organisation of the official services in connexion with the health of plants, the discharge of fiscal duties, the sanitary examination and control of the Department of Agriculture, etc. Part 4 contains an account of progress in the investigation of diseases of plants, and the work and results in the regional laboratories are described.

Government Museum, Trivandrum, Travancore

The administration report of the Government Museum at Trivandrum for the year 1944–45 is prefaced by statements which imply an unusually strong official confidence in a museum's service. It is somewhat startling to read, for example, that this Museum "has . . . enlarged the minds of the visitors by multiplying their interests, trained their tastes and tended to develop in them an appreciation of the beautiful". Nevertheless, the attendance figures brought forward to support these and other claims certainly indicate a service which is of strong appeal to the people. It is noteworthy that during the year the smallest number of visitors to the Museum on any one day was 589, while the largest number was 12,947. Casts (made by a member of the staff) of sculptures in the temple at Suchindrum are now on exhibition in the Museum; they are described in detail on p. 2 of the report. Dr. J. H. Cousins has prepared a new guide to the Art Museum, which is issued free to visitors, and a small catalogue of the metal images is also available.

Recent Earthquakes

During September, nineteen strong earthquakes were registered by the observatories in Switzerland. The earthquake of September 10 had its epicentre near V. Camonica in the Italian Alps; that of September 12 in the Shansi province of China, and those of September 29 and 30 in the Solomon Islands and Peru respectively. During October, fifteen strong earthquakes were registered in Switzerland. That of October 23 occurred in the Karnische Alps near Trieste, and that of October 30 in the Aleutian Islands. During the first half of November, there were six strong earthquakes in various parts of the globe. That of November 1 occurred in the Aleutian Islands and that of November 2 was destructive in the Uzbeck and Kirghiz districts of the U.S.S.R. The earthquake of November 3 had its epicentre approximately on the equator at long. 17° W., whereas that of November 4 had its epicentre near lat. 40° W., long. 53·5° E. near the Caspian Sea. Epicentres of the above earthquakes in November have been obtained, using instrumental reports from observatories, by the U.S. Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, as well as by the International Seismological Office at Strasbourg. The U.S. Coast and Geodetic Survey has also determined the epicentres of the earthquakes of November 10 and 12. The former was destructive near Sihuas, about 225 miles north of Lima in Peru, and the latter occurred near lat. 21° S., long. 173° W.

Economic Reconstruction in Great Britain

The Council of the Royal Society of Arts has decided to devote eight of the remaining ordinary meetings during the present session to a series of eight lectures, dealing with various aspects of economic reconstruction in Great Britain. The lectures will be given at the Society's House in John Adam Street, Adelphi, London, at 5 o'clock, on Wednesdays, the first being on January 15, and will be followed in all cases by an open discussion. The topics to be dealt with include the relation of Britain to the world trade situation, scientific approach to labour problems, materials, finance, craftsmanship, production, distribution and economics.

Announcements

Mr. W. C. F. Hessenberg, chief officer of the Liaison Department of the British Non-Ferrous Metals Research Association, has been appointed head of the Mechanical Working Division of the British Iron and Steel Research Association, and will take up his new post in a few months time.

It is announced by British Drug Houses, Ltd., that Dr. F. Hartley, Dr. C. Ockrent, Mr. H. G. Rolfe and Mr. G. F. Williams have joined the board of the company. Dr. F. H. Carr and Mr. R. R. Bennett have retired from active participation in executive work, but Dr. Carr will continue as chairman of the company and Mr. Bennett as director.

Erratum.—Miss Mariam George, writing with reference to the communication "Synergic Action of Penicillin and Bacteriostatic Dyes" (*Nature*, November 16, 1946, p. 709), states that in the two tables, the minimum inhibiting concentration of dyes should be $\frac{1}{1\cdot75} \times 10^{-6}$, $\frac{1}{2} \times 10^{-4}$, etc., instead of $1\cdot75 \times 10^{-6}$, 2×10^{-4}, etc.

LETTERS TO THE EDITORS

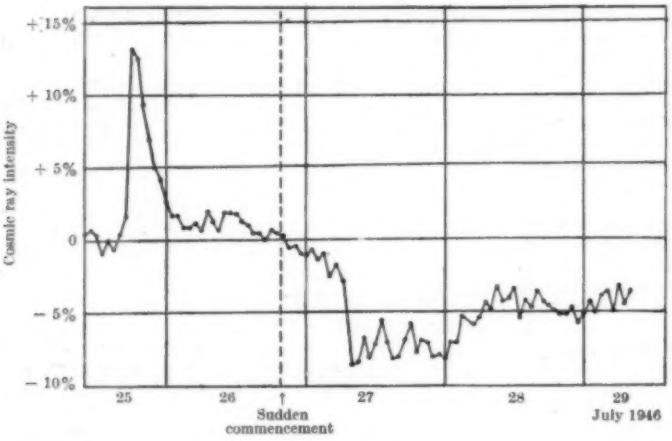
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Cosmic Ray Intensity at Manchester and Solar Disturbances of July 25, 1946

RECENT correspondence in *Nature*[1,2,3] has directed attention to phenomena connected with the great sunspot and solar flare of July 25, 1946, onwards, including a large increase in solar noise and a great geomagnetic disturbance.

The accompanying figure shows a cosmic ray disturbance which was recorded in Manchester at this time. The amplitude of the positive-going peak of about 13 per cent above normal hourly rate makes this disturbance unusual.

Three independent intensity recorders are in operation at Manchester, and the main features of the storm were reproduced in each. Two of them count at the rate of 65,000 three-fold coincidences per hour, and the third at the rate of 30,000 two-fold coincidences per hour. As the hourly rates for the first two were for the intervals 16 hr.–17 hr., etc., and for the third recorder for the intervals 16.30–17.30, etc., it is possible to deduce half-hourly rates for the rise of the peak. This gives the maximum as occurring between 18.00 and 18.30 G.M.T., and of amplitude 17 per cent above the normal half-hourly rate.



According to detailed information kindly supplied by the Astronomer Royal, the magnetic disturbance had ceased by about 10 hr. on July 27. At this time, however, the cosmic ray intensity was still about 8 per cent below normal. A very slow recovery, as usual, resulted in more than a week elapsing before the pre-storm level was regained.

No unusual effect was recorded in Manchester corresponding to that reported from Lahore[4].

The only previously reported peaks appear to have been those associated with the cosmic ray storm of February 28–March 10, 1942. An amplitude of about 8 per cent above normal bi-hourly rate was measured for each of the two peaks that occurred then[5,6].

On these two occasions, when sudden increases in cosmic ray intensity have been recorded, they have occurred some hours before the commencement of the magnetic disturbance. This period was 17 hours for the 1942 storm[5] and 25 hours for the 1946 storm considered here.

D. W. N. DOLBEAR
H. ELLIOT

Physical Laboratories,
The University, Manchester 13.
Nov. 25.

[1] Ellison, M. A., *Nature*, **158**, 160 (1946).
[2] Ellison, M. A., *Nature*, **158**, 450 (1946).
[3] Lovell, A. C. B., and Banwell, C. J., *Nature*, **158**, 517 (1946).
[4] Sarna, H. R., and Sharma, O. P., *Nature*, **158**, 550 (1946).
[5] Lange, I., and Forbush, S. E., *Terr. Mag.*, **47**, 331 (1942).
[6] Duperier, A., *Proc. Phys. Soc.*, **57**, 473 (1945).

Measurements of Changes of the Phase-Paths of Radio Waves in the Ionosphere

MEASUREMENTS of the heights of reflexion of short radio waves returned from the ionosphere have usually been restricted to measurements of the 'group' or 'equivalent' path travelled by the waves. The group path, P', is given by

$$P' = c\int_{\text{path}} \frac{ds}{U}, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where U is the group velocity of the waves over the distance ds. Measurements of P' are most easily made by pulse methods. It is possible also to define the 'optical' or 'phase' path of a wave by

$$P = c\int_{\text{path}} \frac{ds}{V}, \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where V is the phase or wave-velocity of the wave over the distance ds.

Several authors[1] have described modifications of the pulse technique whereby changes of phase-path may be measured, but these methods do not provide a means of distinguishing between an increase and a decrease of phase-path. Appleton[2] has described how the frequency-change method may measure both the rate of change of phase-path and the sense of the change. The purpose of the present note is to describe a modification of the pulse method, which allows of the determination of both the magnitude and the sense of a change of phase-path.

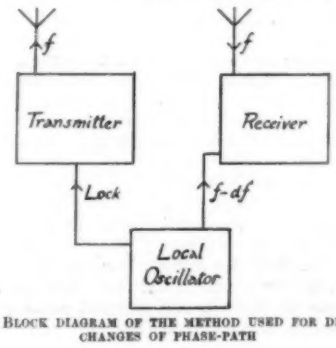


Fig. 1. BLOCK DIAGRAM OF THE METHOD USED FOR DETECTING CHANGES OF PHASE-PATH

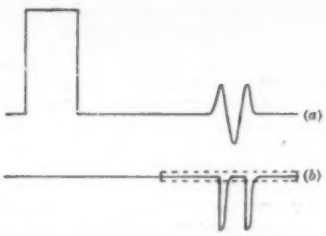


Fig. 2. (*a*) THE FORM OF AN ECHO RETURNED FROM THE IONOSPHERE BEATING WITH THE LOCAL OSCILLATOR. (*b*) MODIFIED FORM OF (*a*)

The usual arrangement of a transmitter which emits a regular succession of pulses is used. These pulses are received and displayed on a linear time-base which is synchronized with the emission of the pulses. This arrangement is modified, as is shown in block form in Fig. 1. A local oscillator injects a signal of frequency about 15 kc./sec. less than the frequency of the transmitter, through an attenuator, into the first circuit of the receiver. The local oscillator is started by the same pulse that starts the transmitter; but the oscillator then continues to oscillate for about 10 millisec., while the transmitted pulse lasts for only 150 microsec. This method of starting the local oscillator and the transmitter ensures that the radio-frequency oscillations in each start in the same phase.

The down-coming pulse from the ionosphere arrives at the receiver together with the signal from the local oscillator, and the two beat together, since they differ in frequency. The amplitude of the signal injected from the local oscillator is adjusted by the attenuator to be always about the same as that of the down-coming pulse. The beat frequency is displayed on the linear time-base, where it has the appearance shown in Fig. 2 (*a*). If the phase-path of the wave which travels to the ionosphere is constant, then the pattern remains stationary on the time-base. If the phase-path increases by one wave-length of the transmitted frequency, the pattern moves to the right by a distance equal to the distance between successive crests of the pattern. If the phase-path decreases by one wave-length of the transmitted frequency, the pattern moves to the left by a distance equal to the distance between successive crests of the pattern.

To enable the total change of phase-path to be recorded, the pattern of Fig. 2(*a*) is transformed by electrical means into that of Fig. 2(*b*). This trace is then photographed through a slit on to a strip of paper which moves perpendicularly to the trace at a constant speed. The type of record obtained is shown in Fig. 3. Decreases of phase-path of one wave-length appear as white lines sloping downwards from left to right; increases appear as white lines sloping upwards from left to right. The total change of phase-path is obtained by counting the number of wave-lengths by which the path changes, and multiplying this number by the wave-length of the transmitter.

This method has been used to study the changes of phase-path of pulses returned from the *E*- and the *F*-layers of the ionosphere. Wave-lengths of 150 metres and 75 metres have been used. Although the method is sensitive to changes of path of less than one wave-length, the accuracy is, in fact, limited by the stability of the frequency of the transmitter and of the local oscillator. At present, changes of path which occur in a few minutes can be measured to an accuracy better than 100 metres.

On twenty occasions during the observations of pulses returned from the *E* region, Dellinger fade-outs have occurred. In all these occurrences, the start of the fadeout has been marked by a rapid reduction of phase-path, taking place in about a minute, and being of the order of one kilometre in size. The recovery of the echo after the fade-out has been associated with a slower increase of phase-path, usually of the same size as the initial decrease.

One possible explanation of this change of phase-path is that it is caused by the change in phase-velocity of the radio waves in the region causing the increased absorption of echoes during the fadeout. If this explanation is adopted, and if the change in echo amplitude associated with the change in phase-path is known, it is possible to estimate the collisional frequency of the electrons with the neutral atoms in the region causing the fade-out. Values for this quantity for the twenty fade-outs vary from $1{\cdot}6 \times 10^5$ per sec. to $5{\cdot}5 \times 10^5$ per sec., with a mean value of $3{\cdot}6 \times 10^5$ per sec.

The behaviour of region *E* is not always such as to give the record of changes of phase-path illustrated in Fig. 3. Such records are generally obtained when the region is 'quiet' in the sense used by Best, Farmer and Ratcliffe[3]. When the region is 'disturbed' the type of record shown in Fig. 4 is obtained. The echo fades and shows discontinuous changes of phase-path. Sometimes parts of the echo show very different rates of change of phase-path from the rest. Qualitatively these results could be explained by the *E* region, when disturbed, having local irregularities in ionization density.

J. W. FINDLAY

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Nov. 22.

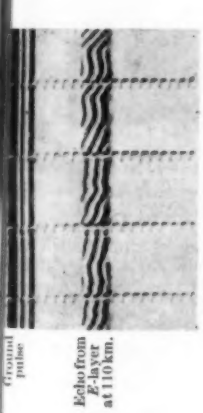

Fig. 3

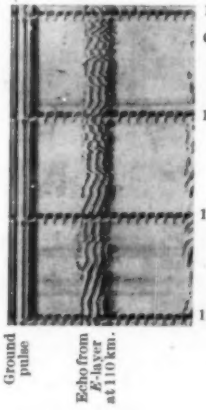

Fig. 4

Fig. 3. SPECIMEN RECORD OBTAINED FROM THE *E*-REGION OF THE IONOSPHERE, WHEN THE REGION IS 'QUIET'

Fig. 4. SPECIMEN RECORD OBTAINED FROM THE *E*-REGION OF THE IONOSPHERE, WHEN THE REGION IS 'DISTURBED'

[1] Hafstead and Tuve, *Proc. Inst. Rad. Eng.*, (2), **17**, 1786 (1929). Ranzi, *Nature*, **132**, 174 (1933).
[2] Appleton, *Proc. Phys. Soc. Lond.*, **42**, 321 (1930); *Proc. Roy. Soc.*, A, **126**, 548 (1930).
[3] Best, Farmer and Ratcliffe, *Proc. Roy. Soc.*, A, **164**, 96 (1938).

Relativistic Wave Equations

DIRAC's wave equation of a free electron may be expressed in the form

$$(i\alpha_\mu\partial^\mu + \chi)\ \psi = 0, \quad . \quad . \quad . \quad (1)$$

where the matrices α_μ ($\mu = 0, 1, 2, 3$) obey the commutation relations

$$\alpha_\mu\alpha_\nu + \alpha_\nu\alpha_\mu = 2g_{\mu\nu}. \quad . \quad . \quad . \quad (2)$$

The usual notation is used, and $g_{\mu\nu}$ is the metric tensor for flat space-time given by $g_{00} = 1$, $g_{11} = g_{22} = g_{33} = -1$, the other components vanishing. The commutation relations (2) are such that from the first-order equation (1) one may deduce the second-order equation

$$(\partial_\mu\partial^\mu + \chi^2)\ \psi = 0. \quad . \quad . \quad . \quad (3)$$

In Kemmer's theory of the meson there are used certain matrices β_μ ($\mu = 0, 1, 2, 3$) which satisfy the commutation relations

$$\beta_\mu\beta_\nu\beta_\rho + \beta_\rho\beta_\nu\beta_\mu = g_{\nu\rho}\beta_\mu + g_{\mu\nu}\beta_\rho, \quad . \quad (4)$$

which ensure that the first-order equation

$$(i\beta_\mu\partial^\mu + \chi)\ \psi = 0$$

is consistent with the second-order equation (3).

The relations (4) are not symmetrical in all the suffixes, unlike in (2) where there is complete symmetry. Let us suppose that there exist $\varepsilon_\mu (\mu = 0, 1, 2, 3)$ which satisfy the symmetrical relations

$$(\varepsilon_\mu\varepsilon_\nu + \varepsilon_\nu\varepsilon_\mu - 2g_{\mu\nu})\varepsilon_\rho + (\varepsilon_\nu\varepsilon_\rho + \varepsilon_\rho\varepsilon_\nu - 2g_{\rho\nu})\ \varepsilon_\mu + (\varepsilon_\rho\varepsilon_\mu + \varepsilon_\mu\varepsilon_\rho - 2g_{\mu\rho})\varepsilon_\nu = 0. \quad (5)$$

It is readily seen that α_μ and β_μ both satisfy (5). That is, the matrices α_μ and β_μ are possible representations of ε_μ. It would be of interest to see if, apart from α_μ and β_μ, there exist other representations of ε_μ, and if so whether they may be used to formulate a theory of particles. If we assume for a moment that a representation of ε_μ exists, we should then see whether the commutation relations satisfied by ε_μ are such that the first-order equation

$$(i\varepsilon_\mu\partial^\mu + \chi)\ \psi = 0, \quad . \quad . \quad . \quad (6)$$

leads to the second-order equation (3). It is easy to show that the commutation relations (5) satisfy this requirement. We operate on (6) from the right by $(\varepsilon_\nu\varepsilon_\rho + \varepsilon_\rho\varepsilon_\nu)\ \partial^\nu\partial^\rho$, and use (5). Then from (6) we obtain $\chi(\partial_\mu\partial^\mu + \chi^2)\psi = 0$, which is equivalent to (3) when χ is not zero.

Now we come to the question of the representations of ε_μ. So far as I am aware, the possible general representations of ε_μ given by (5) have not been investigated. It appears to me likely that the general relations (5) alone may not be sufficient to ensure a finite representation. More stringent requirements may be necessary. These extra conditions should be consistent with (5) and also should be relativistically invariant. Examples of such conditions are (2) and (4), which give the known representations α_μ and β_μ respectively. It is not impossible that there may be other conditions which give new representations of ε_μ different from α_μ and β_μ.

This question is being investigated further and will be dealt with in a later communication.

C. JAYARATNAM ELIEZER

Christ's College,
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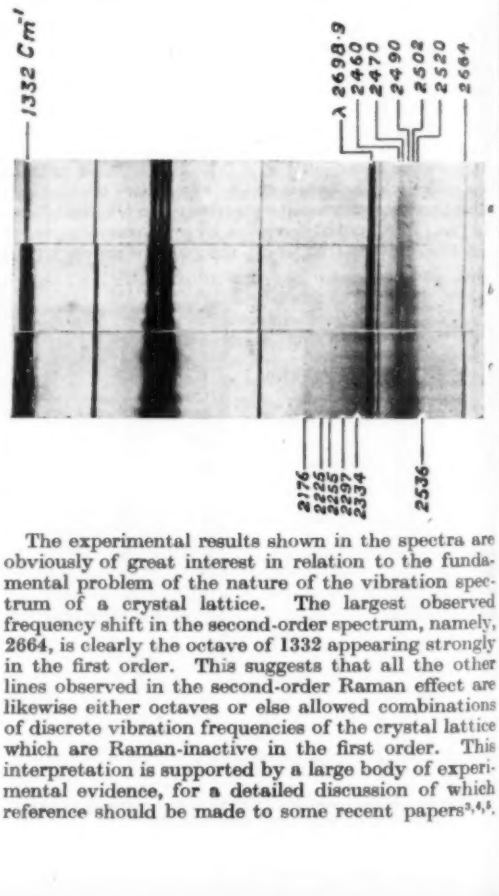
Nov. 4.

Raman Spectrum of Diamond under High Resolution

USING the λ 2536·5 radiation of the mercury arc as the exciter and a Hilger 'Intermediate' quartz spectrograph, the faint second-order Raman spectrum of diamond was first successfully recorded by me[1]. Later investigations[2,3] with somewhat larger diamonds and with a more powerful instrument, namely, a Hilger 'medium' quartz spectrograph, resulted in a notable improvement in the clarity of the recorded spectra. I have now succeeded in obtaining a satisfactorily exposed picture with a 'large' Hilger quartz spectrograph. The expectation that the greater dispersion and resolution given by this instrument would enable the true nature of the spectrum to be exhibited unambiguously has been fulfilled. Three prints of varying depth enlarged from the original spectrogram are reproduced herewith. The principal feature noticeable in the spectra is the appearance of a whole series of sharply defined Raman lines clearly resolved from each other. Twelve of the most prominent of these lines have been marked with their respective frequency shifts in wave-numbers from the exciting radiation. The width of the individual Raman lines, as is evident from a comparison with the lines of the mercury arc, is no greater than that arising from the instrumental and photographic factors. Besides those marked, there are other fainter lines just discernible in the spectrogram against a fainter unresolved background of apparently continuous spectrum.



The experimental results shown in the spectra are obviously of great interest in relation to the fundamental problem of the nature of the vibration spectrum of a crystal lattice. The largest observed frequency shift in the second-order spectrum, namely, 2664, is clearly the octave of 1332 appearing strongly in the first order. This suggests that all the other lines observed in the second-order Raman effect are likewise either octaves or else allowed combinations of discrete vibration frequencies of the crystal lattice which are Raman-inactive in the first order. This interpretation is supported by a large body of experimental evidence, for a detailed discussion of which reference should be made to some recent papers[3,4,5].

The main point which emerges from the experimental facts now established is that the vibration spectrum of the diamond lattice in the infra-red region is a discrete one made up of a finite set of monochromatic frequencies. Combinations of these with the non-discrete or continuous spectrum of elastic-solid vibrations in the lower range of frequency would account for the fainter unresolved background observed in the recorded spectra.

R. S. KRISHNAN

Indian Institute of Science,
Bangalore. Nov. 18.

[1] Krishnan, R. S., *Proc. Ind. Acad. Sci.*, A, **19**, 216 (1944).
[2] Krishnan, R. S., *Nature*, **155**, 171 (1945).
[3] Krishnan, R. S., *Proc. Ind. Acad. Sci.*, A, **24**, 25 (1946).
[4] Krishnan, R. S., *Proc. Ind. Acad. Sci.*, A, **24**, 45 (1946).
[5] Ramanathan, K. G., *Proc. Ind. Acad. Sci.*, A, **24**, 150 (1946).

'Thermal Wedge' Theory of the Parallel Surface Thrust Bearing

Messrs. M. C. Shaw and C. D. Strang[1] have criticized the 'thermal wedge' explanation of the parallel surface thrust bearing put forward by A. Fogg in his paper[2] describing his experimental work.

A mathematical treatment of this bearing has been made using the 'thermal wedge' idea, that is, the equation of continuity becomes

$$\frac{\partial}{\partial x}[(1-\gamma\theta)q_x] + \frac{\partial}{\partial y}[(1-\gamma\theta)q_y] = 0,$$

where q_x, q_y are the rates of flow in the x and y directions and the density $\rho = \rho_1(1-\gamma\theta)$, where ρ_1 is the inlet density, θ the rise of temperature from the inlet and γ the factor of proportionality. This paper will be published in due course in the *Proceedings of the Sixth International Congress of Applied Mechanics*. As all the heat in this theory was assumed to be carried away by the oil, the figures produced for the coefficient of friction were too low. It is hoped in a subsequent paper to give the extended theory with viscosity varying across the thickness of the film and heat loss by conduction as well as convection.

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A. CAMERON

Pembroke College, Cambridge.
Nov. 16.

[1] Shaw, M. C., and Strang, C. D., *Nature*, **158**, 452 (1946).
[2] Fogg, A., *J. Inst. Mech. Eng.* (Jan. 1945).

Transport of Heat and Other Properties by Atmospheric Turbulence

THE theory of the turbulent transfer of heat in the atmosphere, based on the concept of the 'mixing length', was introduced by G. I. Taylor[1] in 1915. Modified by D. Brunt[2] to be applicable to a compressible atmosphere, the theory requires that the flow of heat is in the direction of the gradient of potential temperature, and thus is normally downward. From these treatments a close analogy can be drawn between molecular transfer and the larger scale of eddy transfer.

There is, however, a distinct difference between these two mechanisms of transfer for any property the distribution of which itself affects the flow, for example, through the action of buoyancy forces. The possible consequences of this difference with reference to heat transfer in the atmosphere are discussed in a paper which will be published elsewhere.

In this paper it is shown that a component of heat flux, for which the name 'convective turbulence' is suggested, must result from the buoyancy forces. This is always directed upwards, and is thus in general opposed to the downward transfer by mechanical turbulence.

Records of the fluctuations in temperature at fixed levels up to 6,000 ft. which have been made at Cardington with a sensitive quick-response thermometer confirm the importance of convective turbulence, and show that it may at times completely dominate the heat flow. This conclusion is supported by consideration of the heat interchange between the air and the ground over short periods of time in certain types of weather situations. Furthermore, the heat flux due to convective turbulence estimated from the temperature traces on these occasions is sufficient to maintain the interchange of heat between the air and the ground.

Convective turbulence has further important applications in helping to explain the increase of potential temperature with height in the troposphere, and the temperature distribution in the stratosphere.

Although the work which has been done so far is concerned only with the transfer of heat, the distinction between eddy and molecular processes has important applications in the transfer of other properties, for example, water and dust content in the atmosphere, salinity of the ocean and possibly momentum.

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W. C. SWINBANK

Meteorological Office, Air Ministry,
Dunstable, Beds.
Nov. 18.

[1] Taylor, G. I., *Phil. Trans. Roy. Soc.*, A, **215** (1915).
[2] Brunt, D., *Proc. Roy. Soc.*, A, **124** (1929).

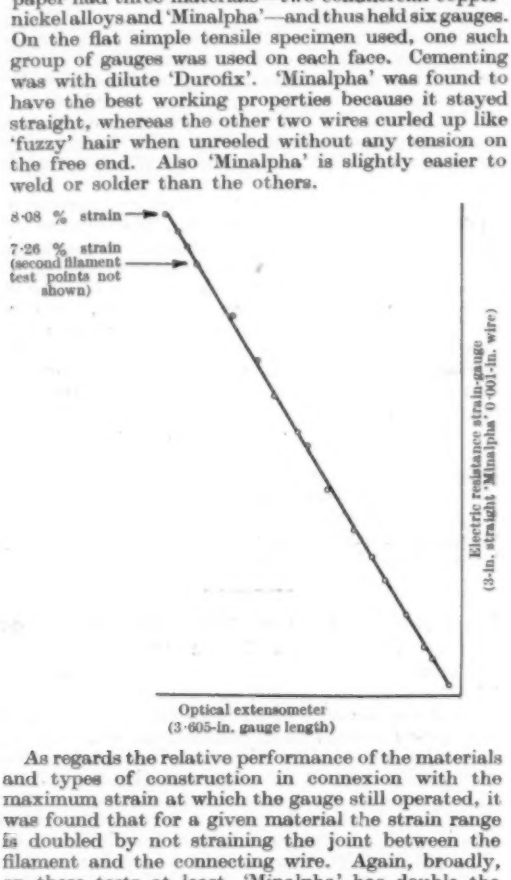
Electrical Resistance Wire Strain-Gauges to Measure Large Strains

I WISH to direct attention to the performance of 'Minalpha' wire as supplied by Johnson Matthey when used as the filament in an electrical resistance wire strain-gauge, and also to indicate the effect of the connexion between the filament wire and the stout wire used to connect it to the measuring bridge.

This type of strain-measuring gauge uses a very fine metal filament (50 gm. 0·001-in. diameter is usual) stuck to a paper base with cellulose cement. The paper, which acts as the insulator for the filament, is stuck to the surface on which the strain is to be measured. As the filament wire is strained, its electrical resistance changes and is measured on a suitable bridge. Calibration of the resistance change gives a measure of the strain.

I wished to find a material and the conditions necessary for satisfactory operation of gauges at large strains. A lightly stretched strip of condenser tissue was hung vertically, and then the various 0·001-in. diameter wires, each with a tension of about 2 gm., were hung in front of it. 'Durofix', diluted one-to-one with butyl acetate, was used to stick the wires to the paper. The paper had been prepared with flapped holes through which the stout connecting wires could be soft-soldered or spot-welded to the fine filaments. All gauges used were made in one strip in this manner to ensure that they were

as nearly similar as possible. The filaments were in pairs of the same material. One filament of each pair was 2¾ in. between the outside circuit connecting wire joints, whereas the other one was 3¼ in. between connexions. Bending the paper base along transverse lines 3 in. apart and between the joints ensured that the joint connexions of one filament would be strained while those of the other filament would be unstrained after cementing to the specimen and loading. Thus the strain performance of each material with and without a joint under strain could be studied. Each paper had three materials—two commercial copper–nickel alloys and 'Minalpha'—and thus held six gauges. On the flat simple tensile specimen used, one such group of gauges was used on each face. Cementing was with dilute 'Durofix'. 'Minalpha' was found to have the best working properties because it stayed straight, whereas the other two wires curled up like 'fuzzy' hair when unreeled without any tension on the free end. Also 'Minalpha' is slightly easier to weld or solder than the others.


8·08 % strain
7·26 % strain (second filament test points not shown)
Electric resistance strain-gauge (3-in. straight 'Minalpha' 0·001-in. wire)
Optical extensometer (3·605-in. gauge length)

As regards the relative performance of the materials and types of construction in connexion with the maximum strain at which the gauge still operated, it was found that for a given material the strain range is doubled by not straining the joint between the filament and the connecting wire. Again, broadly, on these tests at least, 'Minalpha' has double the strain range of the other materials. Thus by using 'Minalpha' wire with an unstrained joint, the strain range of electrical resistance wire strain-gauges may be increased about four times the best available hitherto, since they have been made with a strained joint. This may be seen as a considerable step forward in British electric resistance wire strain-gauge practice, which until recently used nichrome wire with an ultimate strain less than 0·6 per cent, whereas 'Minalpha' operates up to 7–8 per cent strain.

The remarkable linearity of 'Minalpha' electrical strain measurement against optical strain measurement right up to open circuit of the filament is illustrated by the graph. The material is adequately sensitive for use in the small strains range at which these gauges are frequently used. A provisional patent specification has been filed.

Clearly, further work must be done to examine the consistency of performance of 'Minalpha', since only two pairs of gauges have been tested up to the present. However, the present results may stimulate manufacturers and research workers to do further work. My research on post-yield stress and strain causes me to regard gauges as a tool and not as a line of research; but I shall be glad to hear of the experiences of others in this field.

The consequence of finding that 'Minalpha' has such a large strain range is that now strain measurements can be made from zero upwards, since comparator methods, such as photo-grid, can take over when the electric gauge breaks. I can now undertake accurate examination of my post-yield stress-strain theory[1].

K. H. Swainger
Imperial College of Science and Technology,
London, S.W.7. Nov. 26.

[1] *Phil. Mag.*, vii, **36**, 443 (1945).

Hybridization in the Methyl Radical of CH_3X Molecules

In order to interpret the anomalous dipole moments observed in methyl halides, Mulliken[1] has assumed that the *s,p* hybridization of the carbon atom is modified in the different compounds.

Recently, de Hemptinne and Doehard[2] have recorded the Raman spectra of deuterated methyl halides and methyl alcohol in the liquid state. On the basis of certain frequencies assigned to some of the normal modes of these molecules, they have computed the magnitude of others very accurately. This indicates that the form of the potential function is adequately chosen, and makes it practically certain that the numerical values of the force constants given below are correct.

We summarize in the accompanying table the results obtained by these authors, and we include those obtained by us for methyl thiol[3]. The values given for the latter are probably less accurate than the others. But the fact that we have used the same type of potential function makes such a comparison possible.

The symbols for the force constants and distances used in this table are those adopted by de Hemptinne and Doehard. The units are respectively 10^5 dynes and angströms.

		f_{CX}	f_{CH}	d_{CX}	d_{CH}	k	S_{CX}	S_{CH}	
I	CH_3Cl	3·30	4·89	0·240	0·436	0·406	1·71	1·093	72° 30′
	CH_3Br	2·75	4·93	0·174	0·430	0·340	1·90	1·093	72° 30′
	CH_3I	2·28	4·96	0·114	0·429	0·301	2·20	1·093	72° 30′
II	CH_3OH	4·92	4·68	0·432	0·436	0·412	1·43	1·093	72° 30′
	CH_3SH	3·65	4·73	0·360	0·430	0·573	1·82	1·1	72° 30′

Certain features of these results are sufficiently striking to merit special attention. They concern particularly the behaviour of the valency force constant f_{CH} and of the bending force constant d_{CH}.

The former increases by about six per cent with decreasing electronegativity of the adjacent atom, whereas the latter decreases by about one and a half per cent in both groups of compounds[4]. If the decreasing electronegativity is responsible for this effect and tends therefore to strengthen the CH bond, it would be expected that the CH force constant in

CH_4 would be an upper limit for compounds like CH_3X. The value 5·04 given by Herzberg[5] is in agreement with this point of view.

These systematic deviations of the force constants in the CH_3 group could be partly explained by assuming that the changes of electronegativity of the adjacent atom produces changes in the hybridization of the s and p orbitals of the carbon atom. If so, the fact that d_{CH} decreases with the electronegativity, which implies a greater amount of s orbital in the same way, proves that the strengthening of CH is due to the increasing of the s orbital in CH_3 and, therefore, of the p orbital in C—X. This is exactly the hypothesis reached by Mulliken in another way. Our development gives a new and direct support to this hypothesis, which is now extended to alcohols and thiols. It should be noted that the substitution of bromine for one hydrogen in methane lowers the CH bond energy by about 2–3 per cent[6]. The parallelism with the change of the valency force constants is particularly impressive. Furthermore, Penney[7] has shown how the structure of CH_3X compounds is modified by the ratio of mixing s—p of the carbon atom. In taking into account the fact that s increases in CH_3 from CH_3F to CH_3I, one finds immediately that CH_3 tends to become more plane with increasing electronegativity. In regard to the slight changes of hybridization indicated by the above results, we may expect only small but regular deviations from the tetrahedral angle in the series of CH_3X compounds. The ionic character of the carbon-halogen link must also be considered and tends to favour similar deviations, as shown by Penney[7]. Unfortunately, even now the experimental data are not known with sufficient accuracy to test these conclusions. However, we believe that there may be deviations of some degrees.

Nevertheless, a more exact knowledge of the molecular structure is needed to explain the surprising discrepancies between the small changes of hybridization and the considerable perturbations observed in the behaviour of the dipole moments, in particular the large moments of CH_3I (1·59 *D.*) and CH_3SH ($\sim$ 1·39 *D.*). The selectivity effect of the increasing electronegativity on the s orbital should also be cleared up.

It is perhaps worth while pointing out that such a small effect could play an important part in chemical reactions with low activation energies, in particular in biochemical processes. Furthermore, its influence should also be emphasized in the derivatives of conjugated systems. However, further theoretical investigations would be needed for such an extension of our development which, up to the present, can be applied only to carbon atoms in the sp^3 condition.

I am very much indebted to Dr. C. A. Coulson for discussions on certain points.

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Function of Volutin (Metaphosphate) in Mitosis

VOLUTIN is a cytological entity which has long been recognized as an important constituent of the yeast cell. After fixation with formaldehyde and overstaining with methylene blue, it retains the stain when treated with dilute acids. I have devised a staining mixture which makes volutin directly visible in yeast cells; it contains 1·5 c.c. of glacial acetic acid, 4 c.c. of saturated aqueous toluidine blue and 20 c.c. of formalin. Volutin does not contain nucleic acid; ribose nucleic acid granules in the cytoplasm are often referred to as 'volutin', but this is incorrect[1]. Wiame[2] has defined volutin chemically as metaphosphate, thus confirming my view that it is not a nucleoprotein.

The volutin-rich structures in the vacuole of the yeast cell have been identified as chromosomes by their structure and behaviour; they are paired, there is a maximum of twelve of these bodies in each vacuole, and their mitotic division occurs without a visible spindle. It is not possible to find chromosomes regularly in every cell of all preparations. However, I have determined (independently of Wiame) the conditions controlling the appearance and disappearance of volutin. They are as follows: most non-dividing preparations contain volutin in only a few cells (*Torulopsis utilis* is a conspicuous exception to this rule, for its cells retain a considerable amount of volutin at all times). From a few minutes to several hours after non-dividing cells have been placed in an adequate nutrient, containing sources of nitrogen, carbohydrate, and accessory substances, every cell will contain enormous volutin chromosomes in the vacuole, depending on the aeration and the specific culture. As division proceeds the amount of volutin diminishes; in rapidly growing cultures on poor medium the volutin may disappear from the chromosomes of nearly every cell. If the culture is growing rapidly in a very good medium, volutin may be visible on the chromosomes throughout the period of division. Cultures differ in the speed with which volutin disappears, but this may occur shortly after growth ceases in a very rapidly dividing, well-aerated culture. These rules hold for several *Schizosaccharomyces* and *Saccharomycodes* tested, as well as for different species of *Saccharomyces*. *Torulopsis utilis* rarely loses all its volutin, while *T. datilla* loses it readily.

In my earlier paper on yeast chromosomes[1], it was concluded that they were composed of volutin instead of desoxyribose nucleoprotein. Rafalko[3] has since shown that the yeast chromosomes contain desoxyribose nucleic acid and are apparently conventional in this regard. There is another well-recognized desoxyribose nucleoprotein body in the yeast cell. This is the centriolar body which is attached to the outer wall of the nuclear membrane. Lindegren and Lindegren[4] have proposed that the desoxyribose nucleoprotein in the centriole is the equivalent of the heterochromatin in cells of higher organisms, while the vacuolar chromosomes are composed of euchromatin.

The present data indicate that volutin coats the euchromatic chromosome previous to division. This suggests that volutin (metaphosphate) is essential for division, and that only chromosomes coated with volutin are capable of division. This is consistent with Wiame's view that metaphosphate may be a source of energy through its content of energy-rich phosphate

bonds. Once volutin has been metabolized, it must be replaced before the chromosome can divide again. Since the cells of many cultures lose their volutin after division ceases, a lag period occurs when dissimilated cells are introduced into a fresh medium.

When spores are produced, volutin appears in the epiplasm. This may be explained by assuming that volutin is formed in the cytoplasm of normal vegetative cells when adequate nutrients are available, and passes through the nuclear membrane into the vacuole, where it is deposited on the chromosomes. When the cytoplasm is cut off from the nuclear vacuole by the spore wall, volutin accumulates in the epiplasm.

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Synthesis of Cellulose by Resting Cells of *Acetobacter xylinum*

IN plants, cellulose is formed intracellularly, by a process the chemistry of which is completely unknown. Microscopic evidence adduced by Farr suggests that the conditions of cellulose formation in green plants are very complex[1,2]. But in cultures of the bacterium *Acetobacter xylinum*, true cellulose[3,4,5,6] in the form of a mesh of beautifully defined microscopic fibrils occurs as an extracellular product[7,8]. In view of the success which has attended application of bacterial tools to the elucidation of the mechanism of biosynthesis of several polysaccharides[9,10], employment of *A. xylinum* in the study of the mechanism of cellulose formation would seem to be an obvious consideration.

An overwhelming majority of cells in a culture of *A. xylinum* lies immobilized within the tough cellulose pellicle which covers the surface of the fluid. The cells are held tenaciously by this matrix, and they are, therefore, difficult to prepare by usual methods in the form of a free cell suspension. Study of the metabolism of *A. xylinum*, and in particular of the enzymes which enable it to convert an impressive range of substrates[11,12] into cellulose, has been hindered by this circumstance. Recently, however, a method has been found for the conversion of the *A. xylinum* pellicle into a colloidal suspension of cellulose fibrils and cells[8]. It has been found that if this product is run through a cheese-cloth, the latter retains the fibrils but the bacteria pass. A means of obtaining metabolically active cellulose-free cells in good yield from young *xylinum* pellicles is thus afforded. Washed cell suspensions obtained in this way can be stored in a refrigerator for several days without noticeable loss of activity.

When the washed fibril-free cells are added in a high concentration to a solution of glucose (2 per cent) in phosphate-buffer ($m/60$) of pH 5·0 and the mixture is allowed to stand undisturbed in a thin layer (2 mm.) at 37° C. in a Petri dish, a striking reaction can be observed: after about an hour, macroscopic thread-like formations appear; after 2–4 hours, the turbidity of the fluid is reduced, the threads are no longer visible, and instead the bottom of the dish is overlain by a coherent membrane which presents the consistency of a slimy gel. This reaction does not occur in absence of added substrate (glucose).

Under the microscope, the formed gel is seen to consist of a hyaline matrix within which lie numerous bacteria. Treatment of the material with hot 1 per cent sodium hydroxide dissolves the bacteria but not the extracellular matrix. The latter is recovered after the treatment with alkali in the form of a colourless soft translucent mass. The properties of this material (staining reactions, solubility, chemical composition) are those of a cellulose. At the temperature (37° C.) of this experiment, *A. xylinum* completely fails to multiply even in an optimal nutrient solution. Both from this and other reasons it follows that in the conditions described glucose is polymerized to extracellular cellulose in entire absence of cell proliferation.

The ability of the resting cells rapidly to form cellulose in a medium of defined simple composition is by no means limited to the case of glucose substrate. Cells suspended in phosphate buffer formed coherent cellulose membranes within a few hours from fructose, mannitol, and sorbitol, as well as from glucose. In 20 hours they formed membranes also from the following: glycerol, galactose, lactose, sucrose and maltose. In the same conditions the cells completely failed to form a membrane from any of the following: sorbose, mannose, cellobiose (!), erythritol, ethanol and acetate. Since *A. xylinum* oxidizes mannitol to fructose, it is simplest to suppose that this product is a primary intermediary of cellulose formation from mannitol. In the case of sorbitol, on the other hand, it is evident that the reaction of cellulose production must follow a path other than that of oxidation of a C2 group, since it has been shown that sorbose itself does not serve as a substrate of membrane formation.

In connexion with these experiments, the effect of baker's yeast on the process of cellulose formation from polyhydric alcohols is instructive. Baker's yeast, as expected, completely prevented accumulation of fructose in the mannitol solution but not accumulation of sorbose in sorbitol solution; yet, surprisingly, failed in both cases to inhibit membrane production from either of the alcohols. It follows that the process of cellulose production in these cases does not involve any fermentable sugar molecules in the external medium of the cells. It is logical that the large fully formed cellulose entity cannot pass through the cell membrane. Thus it becomes necessary to postulate at least two distinct steps in cellulose production: an intracellular step in which a precursor (possibly a glucosan) of relatively low weight is formed, and an intercellular step in which the high polymer is produced.

Some properties of the overall reaction may be noted briefly. The reaction optimum is found to be at about pH 5·5. The reaction-rate varies in the usual way with substrate concentration, and, within limits, with the cell concentration. Oxygen is essential to the realization of the polymerization, since the cells fail in a nitrogen atmosphere to form a coherent membrane. The dependence on oxidation is further demonstrated by the finding that poisons (cyanide, azide) which inhibit respiration by *A. xylinum* suppress already in low concentration formation of the cellulose membrane. Fluoride, too,

inhibits the reaction, but does so apparently by a different mechanism, since it markedly depresses cellulose production even at a concentration (m/100) in which it does not affect the respiration-rate. It should be noted that the reaction of cellulose production is independent of the specific addition of phosphate to the medium of the cells; but this does not, of course, exclude the possibility that the synthesis is dependent on intracellular presence of phosphate.

It is intended to discuss implications of these findings for the mechanism of cellulose biosynthesis at a future opportunity. Because cellulose production is linked with respiration, the possibility is being further examined whether similar energy transfer systems are involved in production of cellulose, as in production of starch or glycogen from plain glucose.

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Vitamin C in English Apples

The restriction in the national diet during recent years have encouraged the search for foodstuffs rich in particular nutrients, and considerable attention has been paid to sources of vitamin C. But while many rare or unusual fruits and plants have been examined, the typical English fruit, the apple, has been practically neglected. For it has been generally assumed that most varieties, with the exception of Bramley's Seedling, are very poor sources of the vitamin. For example, the value given by the Medical Research Council tables[1] is only 5 mgm. ascorbic acid/100 gm. of edible tissue. The tables of Fixen and Roscoe[2], however, quote values lying within the wide range 0·1–31·8 mgm./100 gm., and even higher values have recently been reported for Bramley's Seedling and Sturmer Pippin[3,4,5].

Tests on a limited number of apple varieties were made at Long Ashton in 1945, and the results have already been described[6]. Values higher than 10 mgm./100 gm. were only given by some of the culinary and cider varieties, the latter being richest in ascorbic acid with values up to 34 mgm./100 gm. for the whole fruit. During the 1946 season, more comprehensive tests have been carried out on freshly picked samples, and the values for the dessert and culinary varieties are shown in the accompanying table, expressed as mgm./100 gm. whole fruit. In addition, twenty-nine cider varieties have been tested and their contents of ascorbic acid found to lie within the wide range 7·5–39 mgm. These values are considerably higher than those generally assumed for English apples. Moreover, a number of seedling varieties raised at this Station gave values comparable with those in the table, for of sixteen varieties tested nine came within the range 15–27 mgm./100 gm.

Dessert varieties	Ascorbic acid (mgm./100 gm.)	Culinary varieties	Ascorbic acid (mgm./100 gm.)
Miller's Seedling	7·9	Golden Noble	6·9
Laxton's Superb	13·9	Edward VII	8·5
Cox's Orange Pippin	14·4	Early Victoria	10·8
Allington	15·0	Crawley Beauty	11·8
Ellison's Orange	15·5	Newton Wonder	14·6
Worcester Pearmain	16·0	Arthur Turner	15·3
Lord Lambourne	17·2	Lane's Prince Albert	15·4
Blenheim Orange	18·4	Bramley's Seedling	22·3
Rival	22·5		

As the highest concentration of ascorbic acid is in the skin of the fruit, the values found after peeling are always lower than those for the entire fruit; for example, the pulp of Bramley's Seedling was found to contain 15·5 mgm./100 gm. as against 22·2 mgm. for the unpeeled fruit. Taking into account such losses on peeling, it is still evident that the apple can be a fairly good source of ascorbic acid and one easily accessible. The actual level of the vitamin in a given variety will naturally depend on many factors still be to determined, while the effect of storage must also be considered: there is evidence, however, that storage losses need not be large[3,4].

Although the ascorbic acid is readily oxidized when the juice is pressed out of the fruit, the loss is not excessive in the ordinary methods of baking or stewing (with or without sugar). Tests on samples drawn from a batch of Bramley's Seedling showed that from a half to two thirds of the vitamin remained in the cooked fruit, a value similar to that found by Olliver[7]. No evidence was found for the production of appreciable amounts of interfering reducing substances during cooking.

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Nitrogen Fixation by Farmyard Manures

In previous communications[1] it was reported that the value of farmyard manure (cow dung) is due not only to its nitrogen content but also to its power to fix nitrogen of the air. Our field experiments show that when wet, fresh collected cow dung is added to soil at the rate of 25 tons per acre, 33 lb. of nitrogen present in the cow dung is added and 135 lb. of nitrogen per acre is actually fixed from air, while in the dark the fixation is 65 lb. per acre.

These experimental results regarding the fixation of nitrogen by cow dung appear to be supported by the field trials at Rothamsted[2] and at Woburn[3]. In the Rothamsted field experiments, no combination

of artificial fertilizers has been found to be so effective as farmyard manure in steadying crop-yields from year to year, and there was an increase of soil nitrogen to about three times its original value when farmyard manure was used for more than sixty years, while with ammonium sulphate or sodium nitrate the soil nitrogen remained practically stationary.

In the Woburn experiments, with farmyard manure added at the rate of 105 lb. of nitrogen per acre for thirty years and 82 lb. of nitrogen per acre for twenty years since 1876, the total nitrogen present in the soil in 1876 was 0·156 per cent and in 1927 in the barley plots it was 0·151 per cent, showing a small loss of only 0·005 per cent. In this period 4,790 lb. of nitrogen were actually added to the soil, and the crop grown on the soil absorbed approximately 2,450 lb. at the rate of 49 lb. of nitrogen per year. Hence the soil lost 2,450 lb. of the added nitrogen and about 124 lb. of the soil nitrogen, that is, 51·4 lb. of nitrogen per year. In the five years 1927–32, no farmyard or other manure was added to these plots, and three crops were withdrawn; the soil nitrogen fell from 0·151 to 0·123 per cent, showing a dead loss of 114 lb. of nitrogen per acre. It appears, therefore, that the less-marked loss of soil nitrogen in presence of farmyard manure is due to the fact that the loss is actually compensated by fixation of atmospheric nitrogen in the presence of farmyard manure.

Moreover, the Woburn experiments with the dung obtained by feeding decorticated cotton cake, containing 6·6 per cent nitrogen and maize-meal, with 1·7 per cent nitrogen, did not reveal any superiority of the cake-feeding over corn-feeding in the manuring of wheat and barley.

These observations have not yet been explained; but it appears to be clear that the dung of animals having maize-meal and containing smaller amounts of initial total nitrogen fixes atmospheric nitrogen; this makes up for its deficiency of total nitrogen due to the greater percentage of carbon in the maize-meal and its oxidation.

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Chromosome Numbers of British Species of the Genus *Rorippa* Scop. (part of the Genus *Nasturtium* R.Br.)

Four species of the genus *Rorippa* occur as members of the British flora, one of them (*R. austriaca*) being an alien[1]. Like many British plants, however, their chromosome numbers have only been determined from European material. These counts are given in Table 1.

Table 1

Species	Chromosome number n	Chromosome number 2n	Author
R. sylvestris (L.) Besser		32	Manton[2]
R. islandica (Oeder) Borbás	8		Jaretzky[3]
R. islandica (Oeder) Borbás	16		Scheerer[4]
R. amphibia (L.) Besser		32	Wulff[5]
R. austriaca (Crantz) Besser		16	Manton[2]

Thus the genus includes both diploid and tetraploid species, and one species, *R. islandica*, has both diploid and tetraploid forms.

In connexion with a survey of the possible relatives of diploid and tetraploid watercress (*Nasturtium officinale* and *N. uniseriatum*)[6], I have counted the chromosome numbers of British specimens of *Rorippa* species. These counts are given in Table 2.

Table 2

Species	Chromosome number n	Chromosome number 2n	Locality
R. sylvestris	24	48	Newry, etc.
R. islandica		32	Thames bank wall, Kew
R. amphibia		16	Thames bank wall, Kew
R. austriaca		16	Waste ground by Thames (Chiswick).
× *R. erythrocaulis* Borbás		24	Thames bank wall, Kew

The discrepancy between the two counts for *R. sylvestris* have been previously discussed[7]. The specimen of *R. islandica* of which the chromosome number was counted was of the type with fruits of normal length. It would be interesting to know whether the type of this species with short fruits (var. *microcarpa*)[8] is the form with a somatic chromosome number of $2n = 16$. My count for *R. amphibia* disagrees with the previous count, and it appears that this species also includes diploid and tetraploid forms, as does *R. islandica*.

The hybrid × *R. erythrocaulis* has been determined from its morphology[9] to be *R. amphibia* × *R. islandica*. Its somatic chromosome number of 24 confirms the suggestion that it comes from the cross *R. amphibia* ($n = 8$) × *R. islandica* ($n = 16$), and it is interesting to note that both the parents still occur in its vicinity. Pollen mother-cells of this hybrid showed 7–8 bivalents and 10–8 univalents.

My thanks are due to Mr. N. Y. Sandwith of Kew for collecting the specimens, and to Mr. V. Chapman for making the cytological preparations.

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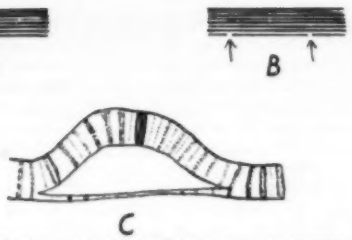
Production of Structural Changes in Somatic Chromosomes of *Drosophila melanogaster*

Auerbach[1,2,3,4] reported that the exposure of adult males to the vapours of allyl isothiocyanate increases the mutation-rate in *Drosophila melanogaster*. About a fifth of the lethals thus produced were found by Slizynska and Slizynski[5] to be connected with cytologically detectable deficiencies, and in addition, there were about 7 per cent of gross structural changes. Auerbach[3] found also that the same chemical treatment of female embryos leads to high frequency of mosaicism, which is almost solely due to somatic crossing-over.

In this connexion an experiment has been carried out using a method described by Slizynska and Slizynski[6] for the production of somatic structural changes observable in salivary gland chromosomes. Freshly laid eggs were divided into three lots. The



Mechanism of origin of partial somatic structural changes in salivary gland chromosomes. *A*: salivary gland chromosome at a stage of 8 chromonemata. *B*: the agent produced breaks or other changes excluding the part between the arrows from the continuity of multiplying chromonemata. *C*: The fully developed salivary gland chromosome with a side connexion formed by the union of two ends. The diagram illustrates the origin of partial deficiency

first lot received no treatment, the second lot was treated with X-rays (400 r.) 5–12 hours after being laid. The third lot was exposed at the same time and age to the vapour of allyl isothiocyanate. I am indebted to Dr. J. M. Robson of the Department of Pharmacology, University of Edinburgh, for carrying out the chemical treatment.

The salivary gland chromosome of the fully grown larvæ was examined in order to detect somatic structural changes. From earlier work on the irradiation of young embryos, it was known that these changes when produced during early stages of the development of salivary gland chromosomes usually appear as narrow connexions between more or less distant parts of the same or different chromosome. They may be interpreted as deficiencies, inversions, etc., affecting only a part of the whole bundle of chromonemata constituting the salivary gland chromosome. The hypothetical mechanism of their origin is schematically represented in the accompanying drawings.

The results of cytological examination of forty-two slides, each with the salivary gland of a single larva (containing on the average 15–20 well-spread nuclei which were examined), are shown in the accompanying table.

FREQUENCY OF SOMATIC STRUCTURAL CHANGES INDUCED BY VARIOUS TREATMENTS

Treatment	Number of larvæ examined	Number of somatic structural changes found
Control	12	—
X-rays	9	55
Allyl isothiocyanate	21	79

The data clearly show that allyl isothiocyanate is very effective in producing somatic structural changes in chromosomes of salivary gland nuclei of *Drosophila melanogaster* when applied during their development, but since the dose given could not be compared with that of X-ray series, nothing can be said about the relative power of this agent in producing somatic structural changes.

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Labilization of the α-Hydrogen of Amino-acids in the Presence of Aminopherase

It has been shown previously in experiments with crude glutamic aminopherase, α-deuterio-alanine and α-ketoglutarate that enzymatic transamination involves dissociation of the α-hydrogen of the original amino-acid and its replacement, in the newly formed amino-acid, by a hydrogen ion derived from the aqueous medium[1]. In the non-enzymatic transamination reaction of Herbst, associated with decarboxylation of the NH_2-donating amino-acid, there occurs no dislocation of labelled α-hydrogen (Herbst and Rittenberg[2]). The reaction mechanisms have been discussed by Herbst[3] and Braunstein[4].

Our studies on the dissociation of α-hydrogen in the presence of aminopherase have been extended to other amino-acids, and the role of α-keto-acids and components of the enzyme system has been investigated. The methods of Schoenheimer and associates[5] were used in labelling *l*-glutamic acid, *dl*-alanine, *l*-leucine, *l*-aspartic acid and glycine with deuterium in the α-position. The enzyme was a highly purified preparation of glutamic-alanine aminopherase[6]. Transamination-rates were measured by colorimetric determination of pyruvate[6], and α-hydrogen dissociation by densimetric estimation of the amount of deuterium passing into the aqueous medium upon incubation[1]. Some of the experimental results are shown in Table 1. (In enzyme-free controls, variations of deuterium-content of the water did not exceed 0·0010 atom per cent; higher excess values are significant.)

Upon incubation of α-deuterio-*l*-glutamic acid with aminopherase, both in the presence of pyruvate or α-ketoglutarate, *and in the absence of α-keto-acids*, that is, when there is no transamination, the α-hydrogen undergoes dissociation, and most of it is recovered in the aqueous medium. In the case of α-deuterio-*dl*-alanine, *there is no dissociation without added keto-acid*. However, approximately half the α-hydrogen (that is, that of one stereoisomer) is labilized, and passes into the water in the presence of ketoglutarate or pyruvate. (In the latter instance the system contains no dicarboxylic reaction partner, known to be essential for transamination proper.) Equilibrium distribution of deuterium is reached even with low amounts of pyruvate (25 μM per 900 μM *dl*-alanine). Acetone fails to replace the α-keto-acids.

With aminopherase solutions inactivated by boiling (15 min.) identical results were obtained: in contrast to the thermolabile catalysis of NH_2-transfer, α-hydrogen labilization is a thermostable function of the enzyme.

In reaction mixtures containing α-keto-acids it has not been possible to detect inhibition of transamination by carbonyl reagents (Vyshepan[7]). With labelled glutamic acid in the absence of α-keto-acid, participation of a catalytically active carbonyl group of the enzyme in α-hydrogen labilization is demonstrated by the total suppression of the reaction by $M/500$ phenylhydrazine, and 50 per cent inhibition by $M/500$ hydroxylamine. The prosthetic group of transaminating enzymes has recently been identified with phosphopyridoxal[8,9,10,11]. In absence of the protein moiety of the enzyme, synthetic phosphopyridoxal[12], added to deuterioglutamic acid (with or without pyruvate), failed to induce α-hydrogen labilization in our experiments (Table 2).

TABLE 1. DISSOCIATION OF α-HYDROGEN FROM α-DEUTERIO-*l*-GLUTAMIC ACID (1·0 ATOM PER CENT D) AND α-DEUTERIO-*dl*-ALANINE (1·28 ATOM PER CENT D) IN THE PRESENCE OF GLUTAMIC-ALANINE AMINOPHERASE (25 LENARD – STRAUB UNITS[8]). SAMPLES (TOTAL VOLUME, 6 ML.) INCUBATED 2 HR. AT 38° C.

Composition of samples	With active enzyme		With boiled enzyme		Without enzyme	
	Excess D in water atom per cent	Trans-amination μmol.	Excess D in water atom per cent	Trans-amination μmol.	Excess D in water atom per cent	Trans-amination μmol.
300 μM Glutamate	0·0036	0	0·0034	0	0·0003	0
" " " + 300 μM pyruvate	0·0053	140	0·0037	0	0·0000	0
500 μM " + 500 μM ketoglut.	0·0070	not detectable	0·0070	–	0·0000	–
900 μM Alanine	0·0000	0	0·0002	0	0·0000	0
" " " + 450 μM ketoglut.	0·0054	90	–	0	–	–
" " " + 450 μM pyruvate	0·0079	not detectable	0·0055	–	0·0010	–
900 μM Alanine						
" " " + 450 μM pyruvate	0·0091	–	–	–	–	–
" " " + 25 μM pyruvate	0·0073	–	–	–	–	–
" " " + 300 μM acetone	0·011	0	–	–	0·0011	0

TABLE 2

Composition of samples	Excess of D (atom per cent) in water	
	With enzyme	Without enzyme
300 μM Glutamate	0·0036	0·0000
" " " + 50 μgm. phospho-pyridoxal	—	0·0009
" " " + 50 μgm. phospho-pyridoxal + 300 μM pyruvate	—	0·0006
" " " + M/500 hydroxyl-amine	0·0018	0·0003
" " " + M/500 phenylhydra-zine	0·0006	0·0007

Preliminary experiments have been made with active or boiled glutamic-alanine aminopherase and labelled di- or mono-carboxylic amino-acids *not available for transamination* with this enzyme (aspartic acid, leucine) or with any known transaminating system (glycine). It appears that the α-hydrogen of these substrates is dissociated as readily as in alanine when α-keto-acids are present, while there is no labilization in their absence. It seems also that α-keto-isocaproic acid and glyoxylic acid, though inadequate as NH_2-acceptors in transamination, are able to induce enzymatic labilization of the α-hydrogen of monocarboxylic amino-acids.

Dislocation of α-hydrogen in glutamic acid can be interpreted as due to reversible condensation of the amino-group with the carbonyl in the prosthetic component of aminopherase to form a prototropic system (Schiff's base)[3,4], but it is not clear at present why alanine and the other amino-acids tested, except glutamic, fail to react unless a keto-acid is present.

It appears from the reported data that (*a*) labilization and dissociation of α-hydrogen, and (*b*) transfer of NH_2-groups (and electrons) are two distinct and successive enzyme-catalysed stages of transamination. Reaction *a* is an independent, relatively non-specific and heat-resistant function of aminopherase, prerequisite for, but not necessarily followed by, reaction *b*.

On the assumption that there exists no enzyme-catalysed exchange of 'stably bound' hydrogen, replacement of the α-hydrogen of amino-acids in isotope experiments with living organisms has been interpreted in several instances as evidence for reversible deamination, especially for dehydrogenation at the α-carbon of the amino-acids[13,14,15,16]. Our data cast a doubt on the validity of this interpretation and suggest a different mechanism for the intravital replacement of α-hydrogen in amino-acids.

A full account of this work, and discussion of its broader implications with regard to enzymatic hydrogen translocations in general, will be published elsewhere.

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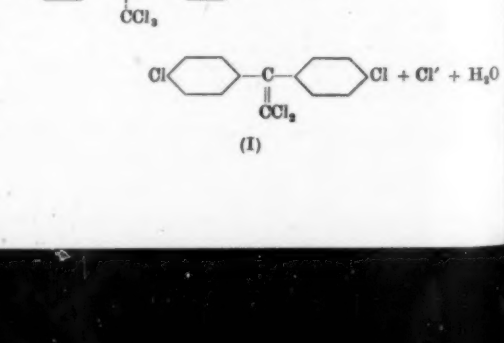
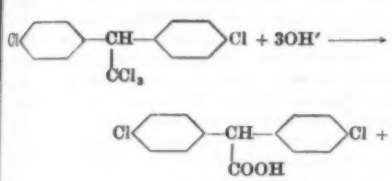
Dehydrohalogenation of *p,p'*-D.D.T.

THE dehydrohalogenation of 2,2-*bis* (*p*-chlorophenyl)-1,1,1-trichloroethane (*p,p'*-D.D.T.) to form 2, 2-*bis* (*p*-chlorophenyl)-1,1-dichloroethylene (D.D.X.), readily brought about by refluxing with alcoholic alkali[1], has been utilized[2-7] for its estimation.



(I)

Such methods are usually based on the determination of chloride ion present in the products of this reaction; and it has hitherto been accepted that under the conditions used, dehydrohalogenation proceeds quantitatively as in the above equation. Our results indicate that this is not so. Thus, when *p,p'*-D.D.T. is refluxed for 30 minutes with *N* alcoholic potassium hydroxide (compare Gunther[2]), some 1·04 chloride ions per molecule of *p,p'*-D.D.T. are liberated, and in addition to D.D.X., ***bis*** (*p*-chlorophenyl) acetic acid can be isolated from the reaction mixture. Although this acid can be readily prepared from both *p,p'*-D.D.T. and D.D.X. by more drastic treatment with alcoholic alkali[6,8,10], D.D.X. is almost completely stable to the action for 30 minutes of boiling *N* alcoholic potassium hydroxide. This suggests that D.D.X. is not normally an intermediate product in the formation of the acid from *p,p'*-D.D.T., but that this arises from a direct hydrolysis of the $-CCl_3$ group to —COOH, a reaction in which three chloride ions are liberated.



(II)

Similar results have been obtained by Cristol and Haller[11] with 2-*o*-chlorophenyl-2-*p*-chlorophenyl-1,1,1-trichloroethane (*o,p'*-D.D.T.). These workers also showed[11] that *o,p'*-D.D.T. treated with alcoholic sodium hydroxide at room temperature loses approximately one molecule of hydrogen chloride per molecule, although some formation of the corresponding acid occurs when the reaction is performed under reflux.

Our results indicate that although treatment of *p,p'*-D.D.T. with 0·1 *N* or *N* alcoholic potassium hydroxide at room temperature can lead to the formation of ***bis***(*p*-chlorophenyl) acetic acid, the amount is too small materially to affect the analytical result. It is, therefore, suggested that such conditions approximate more nearly to those required for the quantitative estimation in accordance with equation I.

Details of this work will be published elsewhere.

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A Marine Bed in the Coal Measures of Northumberland

The absence of true marine horizons—apart from occurrences of *Lingula*—in the Northumberland–Durham Coalfield has long been a matter of surprise to geologists generally. In 1939, however, Mr. Tonks described some small goniatites in calc-ironstone bullion (found in a cabinet of rock-specimens in the Hancock Museum, Newcastle) which had been collected during the sinking, 1858–59, of the Ryhope Shaft, Co. Durham, and, in his paper[1], expressed the hope "that some future pit sinking will yield the rich fauna of the Mansfield–Skipsey band". This discovery by Mr. Tonks indicated the probable existence of such a band, approximately 500 ft. above the High Main Coal seam, which is the boundary on Geological Survey maps between the Upper and Middle Groups of the Coal Measures.

Much of the Northumberland–Durham Coalfield is comparatively shallow, and it is only in isolated parts, due to faulting, or along the east side of Durham—mainly beneath the Permian—that sufficient cover of strata is obtained to include beds 500–1,000 ft. above the High Main. Such areas, for economic reasons, are seldom penetrated by bores or sinkings from the surface; moreover, in the unconcealed part of the coalfield, these outcrops are completely masked by boulder clay. Nowhere in Northumberland has an opportunity occurred for a great many years back to examine these very high Coal Measures strata. This year, however, the Ashington Coal Co. Ltd., started a boring programme, and one bore east of Ashington near the southern boundary of 1-in. Geological Survey Sheet 10 commences in strata approximately 600 ft. above the High Main.

Among the highest strata cored in the above bore is a dark-grey, poorly bedded shale, 1 ft. 5 in. thick, with marine fossils. The shale is at 90 ft. 5 in. below the surface and, as near as can be determined from underground levels, 492 ft. above the High Main. In the bore this shale overlies a 2-in. bituminous coal and is surmounted by a 5-in. ironstone band, also containing traces of shells. The fossils found in the shale are reported as follows:

Productus (*Dictyoclostus*) *craigmarkensis* Muir-Wood.
Productus (*Dictyoclostus*) cf. *retiformis* Muir-Wood.
Productus (*Productus*) *carbonarius* de Koninck.
Lingula sp. (fragments).
Anthracoceras cf. *hindi* Bisat.
Goniatite, gen. et sp. nov. (as described and figured by C. Duncan from Skipsey's Marine Bed[2]).
Metacoceras aff. *cornutum* Girty.
Orthocone nautiloid (probably *Pseudorthoceras* sp.).
Posidonia sulcata (Hind)
? *Parallelodon* sp.
Hindeodella sp.
Streptognathodus sp.
Pleurophorella ?
Small pyritized gastropods and fish debris.

Dr. C. J. Stubblefield and Mr. F. W. Anderson, who determined these, are of the opinion that the 'Ashington Marine Bed' is the Skipsey Marine Bed of Scotland and the Bolton marine horizon of Cumberland. Until the boring programme is completed, however, it is not desirable to go into greater correlative detail.

This preliminary announcement is made with the permission of the Director of H.M. Geological Survey.

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DILATANCY AND THIXOTROPY

A DISCUSSION on the subjects of dilatancy and thixotropy, arranged jointly by the Faraday Society and the British Rheologists' Club, was held on December 10 at the rooms of the Royal Society of Arts. Sir Charles Goodeve, in opening the discussion from the chair, said that the gap between the colloidal chemist and the physicist is being bridged by the rheologist. Mr. R. L. Brown, of the British Coal Utilisation Research Association, gave a survey of researches on the phenomenon of dilatancy; this was followed by a survey of thixotropy by Dr. E. W. J. Mardles.

We owe the term 'dilatancy' to Osborne Reynolds (1885), who established the classical conditions for the onset of turbulence in fluids. The ideas of Reynolds number and of dilatancy apparently arose in an attempt to formulate a mechanical theory of the ether. Reynolds originally observed that a tightly packed mass of sand enclosed in a flexible envelope and subjected to a deformation expanded or dilated (the footprint-on-wet-sand effect). This dilatation is a well-known geometrical necessity for spheres in close packing, the spheres having centrally directed forces between them; but where frictional forces are involved, the expansion takes place along a line of slip and not by a general motion of each particle to a more expanded position. Furthermore, even if the initial arrangement is disordered or if the particles are irregular, lines of slip appear with shear, a co-operative movement of particles occurring whereby whole groups of particles slide where the packing is loose.

Sir Lawrence Bragg[1] has shown in beautiful experiments with soap bubbles in contiguity that the system contains ordered regions which do not mesh perfectly with one another and show an intercrystalline boundary. During dilatation, particles in contact may become separated by gaps; and as forces cannot be transmitted across these gaps, the particle pattern determines the stability of the packing. The pattern of the gaps is the obverse of arching and bridging. Golder[2] sheared, at constant rate of strain, sands and clays contained in a box split along a horizontal plane; and he found that a dense sand dilated, the shear stress rising to a maximum and falling to a constant when dilatation is complete. A loose sand contracted, and the stress rose to a constant value; while brittle clay expanded slightly on shear, and a plastic clay behaved similarly to loose sand.

Freundlich and co-workers, Williamson and Heckert, and others have found with pastes, muds and other concentrated suspensions that dilatancy (indicated by increase in apparent viscosity, consistency or strength with increase in rate of shear) is dependent narrowly on concentration of the solid, being 40–45 per cent for starch or silica. Sheets[3], working with clay slips, found a critical concentration of 60–70 per cent corresponding to close packing, so dilatancy here is in the Reynolds sense, or may be due to the packing characteristic of anisometric particles.

Williamson and Freundlich attribute dilatancy in pastes and suspensions to a 'snowplough' effect: at about 40 per cent concentration, mutual interference of particles occurs and the pattern of flow becomes important. Presumably, the particles become stratified, with clear medium between.

The word 'thixotropy', meaning change by touch, designating the reversible loss of apparent viscosity, consistency or strength of a system, accompanying the application of a shear or the increase in the amount of the applied shear, was first used by Freundlich and Peterfi in 1927 to describe the behaviour of some colloidal systems and suspensions of gypsum, slate powder, etc., which they found to liquefy when shaken or touched and to regain their original solid state after resting. The phenomenon must have been long familiar to those working with plastic masses, sludges and precipitates: v. Kuhne (1863) recorded that a nematode wandering through a muscle cell caused liquefaction with subsequent resetting after rest, and Beilby (1921) in a long series of elegant experiments showed that the surface layers of metals, crystals, etc., could be temporarily liquefied by gentle rubbing. He mentions that barium platinocyanide crystals change from a yellow solid to a brown liquid by pressing them lightly. The range of thixotropic materials extends from the hardest solids, through doughs and pastes to liquids such as blood or milk, which liquids show a reversible decrease in viscosity on movement. Familiar materials, such as furniture cream, cod liver oil emulsion, mayonnaise, greases, clays and muds, quicksands, heather honey, dairy produce, etc., have afforded workers with material for thixotropic study.

Thixotropy is usually a desirable property. It allows of the sharpening of a steel razor by gentle stropping, when liquefaction of the surface layer occurs; although a soap-thickened oil remains rigid in the grease cup, when submitted to shearing stresses in a bearing it liquefies, and its apparent viscosity approaches that of the oil medium itself. Printing inks under the pressure of rollers liquefy and wet the paper, while the spread film solidifies when pressure is released. Thixotropy is of significance in biology: when a sea-urchin egg undergoes division, the fluid protoplasm becomes converted into two jelly-like, semi-solid masses which can be liquefied by jerking with a micro-needle. After removal of the needle, the original jellied condition slowly returns and the division of the egg proceeds normally.

The query whether systems with immediate resolidification after shear liquefaction should be regarded as thixotropic in the same sense as those which require an appreciable time of several minutes or hours for recovery has been raised; but it has been found convenient to consider them as thixotropic as Freundlich did with a 10 per cent silica/carbon tetrachloride suspension, which is liquid on shaking but shows no signs of flowing when the containing tube is inverted immediately after shaking. When a liquid possesses an apparent viscosity which decreases with an increase in the rate of shear, this thixotropy, because of its being associated with stress increase, has been termed 'stress thixotropy', while that associated with strain increase has been termed 'strain thixotropy'. When after shearing there is a loss of consistency but with no return to the original state, this non-reversible behaviour can be termed 'shear breakdown' or 'rheodestruction'. A system showing a decrease in consistency without reaching the fluid state completely has been regarded as possessing false body by Pryce Jones, but such systems are regarded as thixotropic in the sense that a complete transformation from solid to liquid is not a prerequisite for thixotropy; a partial transformation is all that is necessary.

A material can behave both as a rigid solid with measurable rigidity and as a liquid, according to the amount of stress applied; with increase in shearing stress, the threshold at which the material begins to pass from a rigid solid to liquid is called the 'yield value' or 'yield stress'. As Beilby pointed out, the rigidity of a system is a consequence of the molecular aggregation, and Goodeve[4] has considered the yield value in terms of structure to be given by the strength and number of links per unit volume. D/τ diagrams, relating τ, the shearing stress, and D, the rate of shear, form the basis for classification of rheological systems; and this relation of Newton to which rheology owes much of its advance is a convenient form of analysis. The thixotropic time of recovery on D/τ diagrams has been shown by a hysteresis loop when a rising and falling rate of shear has been used.

Thixotropy is especially associated with asymmetric particles. Needles, rods or plates in suspension tend to become orientated in the flow stream, with a consequential lowering of viscosity. Asymmetric particles can form by flocculation a three-dimensional structure at very low concentrations which is easily damaged by shear. Non-spherical particles favour thixotropy, since they will not satisfy the condition of closest packing so necessary for dilatancy.

Thixotropy found with systems of spheres or grains such as precipitated silica appears to be due in the main to flocculation: when flocculation bonds are broken by movement, they tend to heal on resting. The phenomenon of flocculation is not clearly understood, but is closely related to the dispersive power of the medium, which in turn is related to the interfacial activity.

Dr. A. S. C. Lawrence spoke on the temperature coefficient of thixotropy in relation to the rate of flocculation influenced by Brownian movement and viscosity, and mentioned that thixotropy in emulsions with deformable droplets is due to particle asymmetry reaching an axial ratio as high as ten to one.

Mr. J. Pryce Jones gave instances of suspensions altering completely their flow behaviour on the addition of small quantities of colloids and materials which affect wetting; or when the concentration or the rate of shear was increased. The rheology of suspensions is fundamentally dependent on the dispersion coefficient of the medium. Prof. D. H. Bangham, dealing with two properties of solid/liquid interfaces, namely, the heat of wetting and equilibrium contact angle, which appear to have an important bearing on the properties of suspensions, pointed out differences between these two criteria of wettability. Film configurations and 'ghost' interface properties of fine particles become significant or even dominant in dense suspensions where the number of molecules in close proximity to the solid surface is relatively great. Dr. Scott Blair spoke on the sigma phenomenon; a satisfactory explanation was obtained by using a summation equation, allowing for the size of particles relative to the radius of the tube, instead of the integration for a continuum.

Mr. A. de Waal discussed the kinetics of thixotropy, the appearance of yield values in cellulose/ether systems by the change in solvent and the dilatancy of lecithin/glycerol systems with large irregularly dispersed particles. After some discussion on definitions, there was agreement that the time-dependent solid–liquid–solid form of thixotropy, as noted by Freundlich and Peterfi in colloidal systems, forms part of a larger phenomenon when time of recovery to the original state may be immediate. Sir Charles Goodeve, in conclusion, summarized the several important factors responsible for anomalous flow behaviour. He emphasized the need for using carefully designed instruments, pointing out that many 'anomalies' were due to faulty instrumentation. A rational approach to flow problems, he said, is the kinetic one of the time-dependence of linkage-breaking per unit volume; the elastic behaviour of some liquid systems still needs exploration.

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CHEMICAL ENGINEERING AT THE UNIVERSITY OF LEEDS

FOLLOWING the institution of degree courses in chemical engineering by the University of Leeds in 1942, the Department of Coal Gas and Fuel Industries has been acquiring additional items of chemical plant to equip a special laboratory for the study of unit operations. Despite the difficulties imposed by the War and post-war periods, equipment covering most of the principal chemical engineering operations has now been obtained.

The units are sufficiently large to ensure a performance and technique of operation similar to that of commercial plant, and in addition are provided with a full range of measuring instruments. Installations include a double-effect evaporator, still and fractionating column, rocking crystallizer, centrifuge, filter press and rotary vacuum filter, jacketed pan, heat interchanger, tray drier, double-drum film drier, kneading type mixer and a super-centrifuge. Extreme congestion has necessitated housing some of the equipment in outbuildings, but most of it is accommodated in an annexe to the main building which has been named the Charles Brotherton Chemical Engineering Laboratory. The present location is temporary, and when conditions permit, the whole of the equipment will be transferred to an adequate and permanent building.

On December 12, the second Brotherton Lecture of the Society of Chemical Industry was delivered in Leeds by Dr. D. T. A. Townend, and the opportunity was taken of arranging for the temporary Chemical Engineering Laboratory to be formally opened prior to the Brotherton Lecture.

Members of the gas, coking and chemical industries were present. More than a hundred visitors assembled in the Chemistry Lecture Theatre of the University to hear the Vice-Chancellor (Mr. B. Mouat Jones) pay tribute to the many friends represented at the gathering, whose generosity had made possible the implementation of the schemes for chemical engineering training. Once again, he said, the University is indebted to Mr. Charles Brotherton and Messrs. Brotherton and Co., who had provided £55,000 towards the cost of a new building when this became possible, as well as gifts for chemical engineering equipment and endowments to provide staff. The Department had also received most generous and continued support for general equipment from the gas industry, through the Joint Standing Finance Committee of the Institution of Gas Engineers, the

National Gas Council and the British Commercial Gas Association. He also expressed thanks to the many industrial firms for financial support, or for equipment provided either free of charge or under most favourable terms.

Dr. D. T. A. Townend (director, British Coal Utilisation Research Association, and formerly Livesey professor in the University) then gave a brief history of the Department. He paid tribute to the foresight of the late Prof. W. A. Bone, who established courses of training on such a broad basis that they were, in effect, largely chemical engineering. Any doubts there might have been about the need for chemical engineers are now completely resolved by the great and growing demand for such men and, consequently, for their training. For completion, the Leeds courses had needed more facilities for the study of unit operations; now that these were available, although the plant was most inadequately housed, the University could offer with confidence a full and balanced course in the subject.

Visitors then proceeded to the Department of Coal Gas and Fuel Industries, where the brief formal ceremony of opening the Laboratory was performed by Mr. George Brotherton-Ratcliffe, in the unavoidable absence of Mr. Charles F. R. Brotherton. A brief tour of inspection of the Chemical Engineering Laboratory and the Department as a whole was then made.

JAPANESE EARTHQUAKE OF DECEMBER 21, 1946

AT about 04.20 hr. on December 21, 1946, an earthquake of considerable severity originated in the Pacific Ocean some 100 miles off the coast of Wakayama, Japan. The shock was recorded on seismographs throughout the world and was felt, causing some apprehension, in Tokyo. Buildings were shaken, causing damage throughout the island of Shikoku, and on much of the surrounding mainland, including the towns of Hiroshima, Kure, Kobe, Osaka, Kyoto, and Wakayama. The area severely shaken was more than 400 miles long and 150 miles wide, and railway lines were blocked throughout Shikoku. Several villages, including Singu, were severely damaged by fire caused when household fires were scattered about the wooden buildings.

The earthquake was probably accompanied by a sudden alteration of the floor of the ocean in the neighbourhood of the epicentre, because a seismic sea wave or *tunami* resulted, and this caused much damage around the coast. At Koshi, a coastal town with a population of 100,000, and at nearby Takoaka, the wave was a few feet high, and in some places advanced up to five miles inland before retreating. As the wave advanced up the Kii-awadi Straits between the island of Shikoku and the mainland, it became higher until at Osaka, a coastal town with a population of 3,000,000, it attained a height of nearly 10 feet. Kushimoto, a fishing village at the southern tip of Wakayama, was inundated, and the people of Kainan, who climbed on to their roofs and balconies after the first shock, watched the *tunami* roll in a few minutes later, wrecking many houses with a thunderous roar.

Altogether, the official Japanese radio report states that 1,026 people lost their lives, many more were injured and thousands of others rendered homeless. More than 1,400 fishing vessels were wrecked.

This is not the first time that a *tunami* has affected Osaka, lying as it does at the head of an elliptically shaped bay. One followed the great Nankaido earthquake of August 3, 1361, another on October 28, 1707, and yet a third after the Nankaido earthquake of December 24, 1854. These *tunamis* have a speed in some cases of as much as 30 ft. per second, and damage is thus caused by both their height and their speed. Prof. A. Imamura and others have suggested ways of mitigating disasters caused by these seismic sea waves.

The present shock had some of the characteristics of the Kwanto earthquake of September 1, 1923, but was nothing like so severe. On that occasion the first epicentre was in Sagami Bay, causing a vertical displacement of the sea bed of more than 300 ft. and a *tunami* 36 ft. high at the head of the Bay. Tokyo and Yokohama were largely destroyed, and the scattering of the household fires practically burned out what was left of the lower section of Tokyo and nearly all Yokohama. Nearly 100,000 people were killed. The railway bridge spanning the River Banyu-Gawa received a horizontal shaking of intensity equal to half its weight and collapsed, and the whole of the Kwanto earth block tilted a few metres, the south-east rising and the north-west sinking. As a result of the Kwanto earthquake unshipping the earthquake recorders, the Seismological Institute of Tokyo Imperial University later installed a seismograph with a minification of a half. Now, unless an earthquake has a range of motion greater than 13 in., this instrument will record it. E. TILLOTSON

TIMBER DECAY AND ITS CONTROL

LEAFLET No. 39 entitled "Timber Decay and its Control" (Pp. 12), issued by the Forest Products Research Laboratory, Princes Risborough, commences by discussing the methods of growth and general appearance of fungi and the large number of spores usually produced. Since it only requires one or two spores to infect a piece of wood, means must be found to prevent spores germinating and infecting wood. Conditions of growth are then considered and the nature of the decay.

Fungal decay of wood is in reality a chemical decomposition which is brought about by the ferments and acids secreted by fungi. The wood is, as it were, digested by the fungus, and part of it is transformed into liquids which are absorbed by the fungi as nutriment. Wood in an advanced stage of decay represents the residue which is of no use to the fungus, or which has not yet been utilized. Two main types of decay in wood may be distinguished.

1. *Brown Rots.* In these, the wood eventually becomes a dark brown, and in the final stages tends to break up into brick-shaped pieces as a result of cracking along and across the grain. Wood severely attacked by a brown rot can be readily crumbled under the fingers. The most important decays of softwoods are 'brown rots'. Chemically speaking, brown rots are distinguished by the fact that only the cellulose and the associated carbohydrates are attacked, whereas the lignin is left practically unchanged.

2. *White Rots.* Darkening of the wood is sometimes the first indication of the white rot, but eventually it becomes very much lighter in colour than normal.

This lightening in colour may be general or it may occur in patches, causing a white 'pocket' rot. Even in an advanced stage, wood attacked by a white rot does not crumble into powder under pressure, although it may disintegrate into a lint-like material. Most of the decay in felled hardwoods is caused by various types of white rot. The chemical action of a white rot is more complicated than that of a brown rot, since all the constituents of the wood are attacked, the lignin as well as the cellulose being broken down.

Rot in wood is often spoken of popularly as of two types—'wet rot' and 'dry rot'. This is a rather unsatisfactory division, since the two types are both caused by fungi which can only attack the wood when it is definitely damp. Dry rot has, however, come to acquire a rather specialized meaning, as the rot of timber in buildings that is brought about by one or two species of fungi such as *Merulius lacrymans*. This type of rot eventually leaves the wood in a dry, friable condition, but the fungus requires damp, ill-ventilated places in which to flourish, and it cannot attack really dry wood.

The diagnosis, effect and prevention of decay are discussed fully. The leaflet is well illustrated.

FORTHCOMING EVENTS

Saturday, January 11

BOTANICAL SOCIETY AND EXCHANGE CLUB OF THE BRITISH ISLES (at the Randolph Hotel, Oxford), at 3.30 p.m.—Dr. P. W. Richards: "The Biological Flora".

Tuesday, January 14

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2 p.m.—Mr. A. P. Bevan: "The Mechanical Requirements of the Small Grower and Horticulturist".

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Dr. W. D. Wright: "Colour in Illuminating Engineering".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the LIVERPOOL SECTION OF THE SOCIETY, at the University, Liverpool), at 6.30 p.m.—Mr. P. N. Williams: "Synthetic Fats".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. H. P. Staudinger: "Vinylidene Chloride and its Polymers".

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7.15 p.m.—Mr. J. D. Tallantire: "Continuous Process Measurement in Dirty Fluids".

Wednesday, January 15

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Douglas Wallace Bishopp: "The Scope and Future of Geology in Ireland".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Sir Charles Lidbury: "Economic Reconstruction, 1, Great Britain in relation to the World's Trade Situation".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. B. Bleaney, Mr. J. W. Ryde and Mr. T. H. Kinman: "Crystal Valves".

SHEFFIELD METALLURGICAL ASSOCIATION (joint meeting with the YORKSHIRE SECTION OF THE INSTITUTE OF FUEL, in the Lecture Hall, Central Library, Surrey Street, Sheffield), at 6.15 p.m.—Dr. J. H. Chesters and Mr. M. W. Thring: "Factors in Open Hearth Design".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Dr. A. C. Monkhouse: "Recent Advances in Atmospheric Pollution Research".

SOCIETY OF CHEMICAL INDUSTRY, NEWCASTLE-UPON-TYNE SECTION (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6.30 p.m.—Mr. J. M. Pirie: "Silver and Platinum in Chemical Plant Construction".

TEXTILE INSTITUTE, LANCASHIRE SECTION (at 16 St. Mary's Parsonage, Manchester 3), at 7 p.m.—Mr. J. A. McWilliam: "Corrosion Resisting Steels for the Textile Industry".

TEXTILE INSTITUTE, MACCLESFIELD, LEEK AND DISTRICT SECTION (at Nicholson Institute, Leek), at 8 p.m.—Dr. F. C. Toy: "Some Impressions of my American Tour".

Thursday, January 16

ROYAL SOCIETY OF ARTS, INDIA AND BURMA SECTION (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. A. E. Foot: "The Doon School".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. H. L. Talbot: "The Development of Metallurgical Practice for the Treatment of Nchanga Mixed Oxide-Sulphide Ores".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. J. M. Whittaker: "Series of Polynomials".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. H. A. Thomas: "Industrial Applications of Electronic Techniques".

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 6 p.m.—Short Papers on "Recent Developments in Testing Methods for Road and Building Materials".

ROYAL PHOTOGRAPHIC SOCIETY (joint meeting of the SCIENTIFIC AND TECHNICAL GROUP and the COLOUR GROUP, at 16 Princes' Gate, London, S.W.7), at 7 p.m.—Mr. A. Marriage and Mr. D. C. Gresham: "Masking and its Method" ("How it Works in Colour Photography", 3).

TEXTILE INSTITUTE, YORKSHIRE SECTION (at the Midland Hotel, Bradford), at 7 p.m.—Mr. A. W. Robertson: "Glass Fibres, Yarns and Cloths".

TEXTILE INSTITUTE, BELFAST BRANCH (at the College of Technology, Belfast), at 7.30 p.m.—"Plastics Appertaining to the Textile Industry".

Thursday, January 16—Friday, January 17

BRITISH SOCIAL HYGIENE COUNCIL (joint meeting with the TOWN AND COUNTRY PLANNING ASSOCIATION, at the Institution of Civil Engineers, Great George Street, London, S.W.1).—Conference on "The Family at Work and Play" (to be opened by Mr. Gilbert McAllister).

Friday, January 17

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. H. Knowler: "Recent Developments in Flying Boats" (Nineteenth Thomas Lowe Gray Lecture).

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. W. D. Jones: "Flame Spraying of Metals and Plastics".

INSTITUTE OF PHYSICS, INDUSTRIAL RADIOLOGY GROUP (at the E.L.M.A., 2 Savoy Hill, Strand, London, W.C.2), at 6.30 p.m.—Mr. R. Meakin: "Sonic Methods in Non-Destructive Testing".

SOCIETY OF CHEMICAL INDUSTRY, BIRMINGHAM SECTION (at the Chamber of Commerce, Birmingham), at 6.30 p.m.—Mr. J. E. B. Randles: "Applications of the Cathode Ray Oscillograph to Polarography".

INSTITUTE OF THE PLASTICS INDUSTRY, NORTH-WESTERN SECTION (joint meeting with the MANCHESTER SECTION OF THE INSTITUTION OF THE RUBBER INDUSTRY, at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—"German Plastics Industry". Dr. T. Love: "Thermosetting"; Mr. J. H. Rooney: "Thermoplastics".

INSTITUTE OF ECONOMIC ENGINEERING (at Cowdray Hall, Henrietta Place, London, W.1), at 7 p.m.—Annual General Meeting.

PAPER MAKERS' ASSOCIATION (TECHNICAL SECTION), NORTHERN DIVISION (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Mr. C. Brown and Dr. H. Ainsworth Harrison: "Organic Mercurials for Slime Prevention".

CHEMICAL SOCIETY, CAMBRIDGE SECTION (in the University Chemical Laboratory, Cambridge), at 8.30 p.m.—Prof. M. Stacey: "Macromolecules Synthesised by Micro-organisms" (Tilden Lecture).

INSTITUTION OF STRUCTURAL ENGINEERS, LANCASHIRE AND CHESHIRE BRANCH (at the College of Technology, Manchester).—Mr. Leonard C. Howitt: "Architecture Related to Structural Engineering".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR ASSISTANT with qualifications and experience in Chemical Engineering, at the Bradford Technical College—The Director of Education, Town Hall, Bradford (January 18).

ASSISTANT for miscellaneous duties connected with a scientific information service and an abstracting journal—The Director, Imperial Bureau of Dairy Science, Shinfield, Reading (January 18).

LECTURER IN ELECTRICAL ENGINEERING in the Ashington County College and Mining School—The Director of Education, County Hall, Newcastle-upon-Tyne 1 (January 18).

RESEARCH SPECIALISTS (2) IN APPLIED PHYSIOLOGY at the Royal Air Force Institute of Aviation Medicine, Farnborough, Hants.—The Under-Secretary of State, Air Ministry (S.2q), Cornwall House, Waterloo Bridge Road, London, S.E.1 (January 20).

LECTURER IN PHYSICAL, ORGANIC, INORGANIC AND INDUSTRIAL CHEMISTRY, a LECTURER IN DIPLOMA MATHEMATICS (Post Matric. standard), a LECTURER IN DIPLOMA PHYSICS (Post Matric. standard), a LECTURER IN ELECTRICAL ENGINEERING, a LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN CIVIL ENGINEERING, in the Technical Education Branch of the Department of Public Instruction, New South Wales—The Official Secretary, New South Wales Government Offices, 125 Strand, London, W.C.2 (January 25).

LECTURERS (2) IN THE DEPARTMENT OF CHEMISTRY, Leeds College of Technology—The Director of Education, Education Office, Leeds 1 (January 25).

LECTURER IN CHEMICAL ENGINEERING, and a LECTURER IN PHYSICAL CHEMISTRY, at the West Ham Municipal College—The Education Officer, Education Department, 95 The Grove, Stratford, London, E.15 (January 27).

MEDICAL RESEARCH BACTERIOLOGIST—The Clerk of the Board, Metropolitan Water Board, New River Head, Rosebery Avenue, London, E.C.1, endorsed 'Medical Research Bacteriologist' (January 31).

ASSISTANT LECTURER IN ELECTRICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (January 31).

LECTURER IN GEOLOGY—The Registrar, King's College, Newcastle-upon-Tyne (January 31).

LECTURERS (Grade III and Grade II) IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, The University, Liverpool (January 31).

ASSISTANT LECTURER (Grade III) IN THE DEPARTMENT OF PHYSICS—The Secretary, The University, Edmund Street, Birmingham 3 (January 31).

LECTURER IN PHYSIOLOGY—The Secretary, The University, Edmund Street, Birmingham 3 (January 31).

MEDICAL ARTIST—The Dean, British Postgraduate Medical School, Ducane Road, London, W.12 (January 31).

ASSISTANT GOVERNMENT CHEMISTS, NIGERIA—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1 (February 1).

ASSISTANT LECTURER (Grade III) IN OCEANOGRAPHY (Applied Mathematician)—The Registrar, The University, Liverpool (February 8).

SENIOR LECTURER IN ELECTRICAL ENGINEERING at Canterbury University College, Christchurch—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (February 14).

LECTURER IN CHEMISTRY (to deliver lectures in Physical or Inorganic Chemistry), at Auckland University College—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (February 15).

ASSISTANT PHYSICIST—The Secretary, Sheffield National Centre for Radiotherapy, Broom Cross, Tree Root Walk, Sheffield 10 (February 17).

CHAIR OF DESIGN in the School of Architecture, Auckland University College—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (February 28).

POSTS as DIRECTOR in the Imperial Agricultural Bureaux of Animal Breeding and Genetics, and of Forestry—The Secretary, Imperial Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S.W.1 (March 1).

WILDE READERSHIP IN MENTAL PHILOSOPHY—The Registrar, University Registry, Oxford (March 8).

UNIVERSITY GRADUATES and qualified teachers for short service commissions in the Education Branch of the Royal Navy—The Director, Education Department, Admiralty, London, S.W.1.

ENTOMOLOGIST, Bermuda—The Director of Recruitment (Colonial Service), 15 Victoria Street, London, S.W.1.

LECTURER IN CHEMISTRY, and a LECTURER IN ELECTRICAL ENGINEERING, at the Cardiff Technical College—The Director of Education, City Hall, Cardiff.

TECHNICAL ASSISTANT—The General Secretary, Textile Institute, 16 St. Mary's Parsonage, Manchester 3.

PARASITOLOGIST, and an ORGANIC CHEMIST—The Director, Ontario Research Foundation, 43 Queen's Park, Toronto 5, Canada.

RESEARCH CHEMIST—The Director of Research, Cereals Research Station, Old London Road, St. Albans.

BIOCHEMIST (university graduate with experience in clinical biochemistry and familiar with optical method of analysis) in the Ministry of Health Area Laboratory—The Medical Superintendent, City Hospital, Hucknall Road, Nottingham.

LECTURER IN CHEMISTRY—The Clerk, Northern Polytechnic, Holloway, London, N.7.

TECHNICIAN (skilled) as a Physics Research Assistant, and TRAINEE TECHNICIANS for the Departments of Physiology and Pathology—The Secretary, Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1.

RESEARCH ASSISTANT IN THE MECHANICAL TESTING SECTION—The Secretary, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

University of Bristol. Annual Report of the Agricultural and Horticultural Research Station (the National Fruit and Cider Institute), Long Ashton, Bristol, 1945. Pp. 230. (Bristol: Agricultural and Horticultural Research Station, Long Ashton, 1946.) [278

Imperial Agricultural Bureaux. Joint Publication No. 11: Some British Books on Agriculture, Nutrition, Forestry and Related Sciences, 1939–1945. List compiled by H. M. Bedington. Pp. v + 37. (Aberystwyth: Imperial Agricultural Bureau, 1946.) 3s. [278

Imperial Bureau of Plant Breeding and Genetics. The Use of Heteroais in the Production of Agricultural and Horticultural Crops. By T. Ashton. Pp. iii + 30. (Cambridge: Imperial Bureau of Plant Breeding and Genetics, 1946.) 3s. [278

What is UNESCO? Pp. 12. (London: United Nations Educational, Scientific and Cultural Organisation, 1946.) [278

British Colliery Owners Research Association. Report on the Work of the Mining Research Laboratory during the Two Years ended March 1945. By the Director. Pp. iii + 37. (London: British Colliery Owners Research Association, 1946.) [298

Forestry Commission Yield Tables for Scots Pine and other Conifers. Pp. 24. (London: H.M. Stationery Office, 1946.) 6d. net. [298

Ministry of Health. On the State of the Public Health during Six Years of War. Report of the Chief Medical Officer of the Ministry of Health, 1939–45. Pp. iv + 280. (London: H.M. Stationery Office, 1946.) 5s. net. [29

The Place of Research in the Iron and Steel Industry. Pp. 19 (London: British Iron and Steel Research Association, 1946.) [2

Philosophical Transactions of the Royal Society of London. Series B: Biological Science. No. 687, Vol. 232: The Mechanics and Innervation of the Starfish Tube Foot-Ampulla System. By Dr. J. E. Smith. Pp. 279–310. Series A: Mathematical and Physical Sciences. No. 813, Vol. 240: The Calculation of Variable Heat Flow in Solids. By N. R. Eyres, Dr. D. R. Hartree, J. Ingham, Dr. R. Jackson, Dr. R. J. Sarjant and J. B. Wagstaff. Pp. 57. 9s. (London: Cambridge University Press, 1946.) [2

Other Countries

Smithsonian Institution: United States National Museum. Bulletin 185: Checklist of the Coleopterous Insects of Mexico, Central America, the West Indies, and South America, Part 4. Compiled by Richard E. Blackwelder. Pp. iii + 551–763. 50 cents. Bulletin 190: The North American Clear-Wing Moths of the Family Algeriidae. By George P. Engelhardt. Pp. vi + 22 + 32 plates. 75 cents. (Washington, D.C.: Government Printing Office, 1946.) [27

Development and Welfare in the West Indies. Bulletin No. 19: Survey of Animal Husbandry, Feeding, Management and Veterinary Services in the West Indies—Trinidad and Tobago. Report by Prof. Wm. C. Miller. Pp. 40. (Bridgetown: Advocate Co., Ltd., 1946.) 10 cents. [27

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 185: Studies on the Mitchell Grass Association in South-Western Queensland. 2. The Effect of Grazing on the Mitchell Grass Pasture. By R. Roe and G. H. Allen. Pp. 27. Bulletin No. 186: The General Ecological Characteristics of the Outbreak Areas and Outbreak Years of the Australian Plague Locust (*Chortoicetes terminifera* Walk.) By Dr. K. H. L. Key. Pp. 127 + 8 plates. Bulletin No. 191: Studies of the Physiology and Toxicology of Blowflies. 10. A Histochemical Examination of the Distribution of Copper in *Lucilia cuprina*; 11, A Quantitative Investigation of the Copper Content of *Lucilia cuprina*. By D. F. Waterhouse. Pp. 39 + 1 plate. Bulletin No. 193: Post-Miocene Climatic and Geologic History and its Significance in relation to the Genesis of the Major Soil Types of South Australia. By R. L. Crocker. Pp. 56 + 9 plates. (Melbourne: Government Printer, 1945–1946.) [28

Arkiv för Matematik, Astronomi och Fysik utgivet av K. Svenska Vetenskapsakademien. Band 32A, No. 8: Determination of Orbits in the Field of a Magnetic Dipole with Applications to the Theory of the Diurnal Variation of Cosmic Radiation. By Karl Gustav Malmfors. Pp. iii + 64. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.; London: H. K. Lewis and Co., Ltd., 1945.) [28

Stockholms Observatoriums Annaler. Band 14, No. 9: On the Cosmogony of the Solar System, 3. By Hannes Alfvén. Pp. 23. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.: London: H. K. Lewis and Co., Ltd., 1946.) [28

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 100, Nr. 10: East Greenland Lakes as Habitats for Chironomid Larvae; Studies on the Systematics and Biology of Chironomidae, 2. By F. Sogaard Andersen. (Treasure-expeditionen til Christian den X's Land, 1931–34.) Pp. 65 + 2 plates. 3 kr. Bd. 121, Nr. 15: The Zoology of East Greenland—Araneina. By Jens Braendegaard. Pp. 128. 5 kr. Bd. 129, Nr. 3: A Grammar of the West Greenland Language. By C. W. Schultz-Lorentzen. Pp. 104. 5 kr. Bd. 130, Nr. 3: The East Greenland Ice. By Lauge Koch. Pp. 374 + 1 plate. 18 kr. Bd. 142, Nr. 2: Effect of the Climatic Amelioration of the Past Decade on the Autumn Change of Coat of the Arctic Fox in Greenland. By K. Faester. Pp. 18 + 2 plates. 1 kr. (København: C. A. Reitzels Forlag, 1945–1946.) [28

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 144, Nr. 2: On the Hydrography of the Greenland Sea. By A. Kiilerich. (De Danske Expeditioner til Østgrønland, 1926–39, Appendix No. 2.) Pp. 63 + 3 plates. 3.25 kr. Bd. 144, Nr. 3: Summary of the Botanical Investigations in N.E. Greenland. By Thorvald Sørensen. (De Danske Expeditioner til Østgrønland, 1926–39, Appendix No. 3.) Pp. 48 + 1 plate. 2.50 kr. Bd. 144, Nr. 4: Eskimo Settlements in Northeast Greenland. By P. V. Glob. (De Danske Expeditioner til Østgrønland, 1926–39, Appendix No. 6.) Pp. 40. 2 kr. Bd. 145, Nr. 1: Det Danske Stuer af Grønland, 1825–1850. Af P. P. Sveistrup og Sune Dalgaard. Pp. 419. 20 kr. Bd. 145, Nr. 2: Grønlænderne i Danmark; Bidrag til Belysning af Grønlands Kolonisationsarbejde fra 1605 til vor Tid. Af A. Berteisen. Pp. 212. 10 kr. (København: C. A. Reitzels Forlag, 1945–1946.) [28

Conseil Permanent International pour l'Exploration de la Mer. Rapports et Procès-verbaux des Réunions. Vol. 112: Hydrography. Pp. 94. 6 kr. Vol. 113: Rapport administratif (1939–1942.) Pp. 51. 3 kr. Vol. 114: Die Schollenbevölkerung der Helgoländer Bucht und die Einschränkung der Fischerie während der Kriegsjahre 1914–1918 und 1939–1942. Von A. Bückmann. Pp. 42. 3.50 kr. Vol. 115: International Exploration of the Sea, by Johan Hjort; The Stock of Sea Fishes and the International Convention, London, 1937, by Henry Baeis. Pp. 51. 3 kr. Vol. 116: Procès-verbaux (October 1945); Rapport administratif (1942–43, 1943–44 et 1944–45). Pp. 50 + 53. 6 kr. (Copenhague: Andr. Fred. Høst et fils, 1943–1946.) [28

Catalogues

Double-Telescope Somet Binar 25 × 100. Pp. 4. (Prague: MEOPTA United Works for Fine Mechanics and Optics, 1946.)

Towers Laboratory News. No. 3. Pp. 33–48. (Widnes: J. W. Towers and Co., Ltd., 1946.)

pH at the End of a Pointer. (Bulletin B.569B.). Pp. 4. (Beckenham: Muirhead and Co., Ltd., 1946.)

Ross Allen's Reptile Institute Fall and Winter Catalog. Pp. 20. (Silver Springs, Fla.: Ross Allen's Reptile Institute, 1946.)

Bowes and Bowes Book Bulletin. Autumn 1946. Pp. 16. (Cambridge: Bowes and Bowes, 1946.)

A List of the Publications of the Hakluyt Society. Pp. 16. (London: Bernard Quaritch, Ltd., 1946.)

A Catalogue of Books of English Literature and History, together with Books from Modern Presses. (No. 642.) Pp. 80. (London: Bernard Quaritch, Ltd., 1946.)